A REPORT ON THE BALLARAT WATER SUPPLY CATCHMENTS

A PROPOSAL FOR PROCLAMATION
PREPARED FOR CONSIDERATION BY
THE LAND CONSERVATION COUNCIL

By

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March 1979

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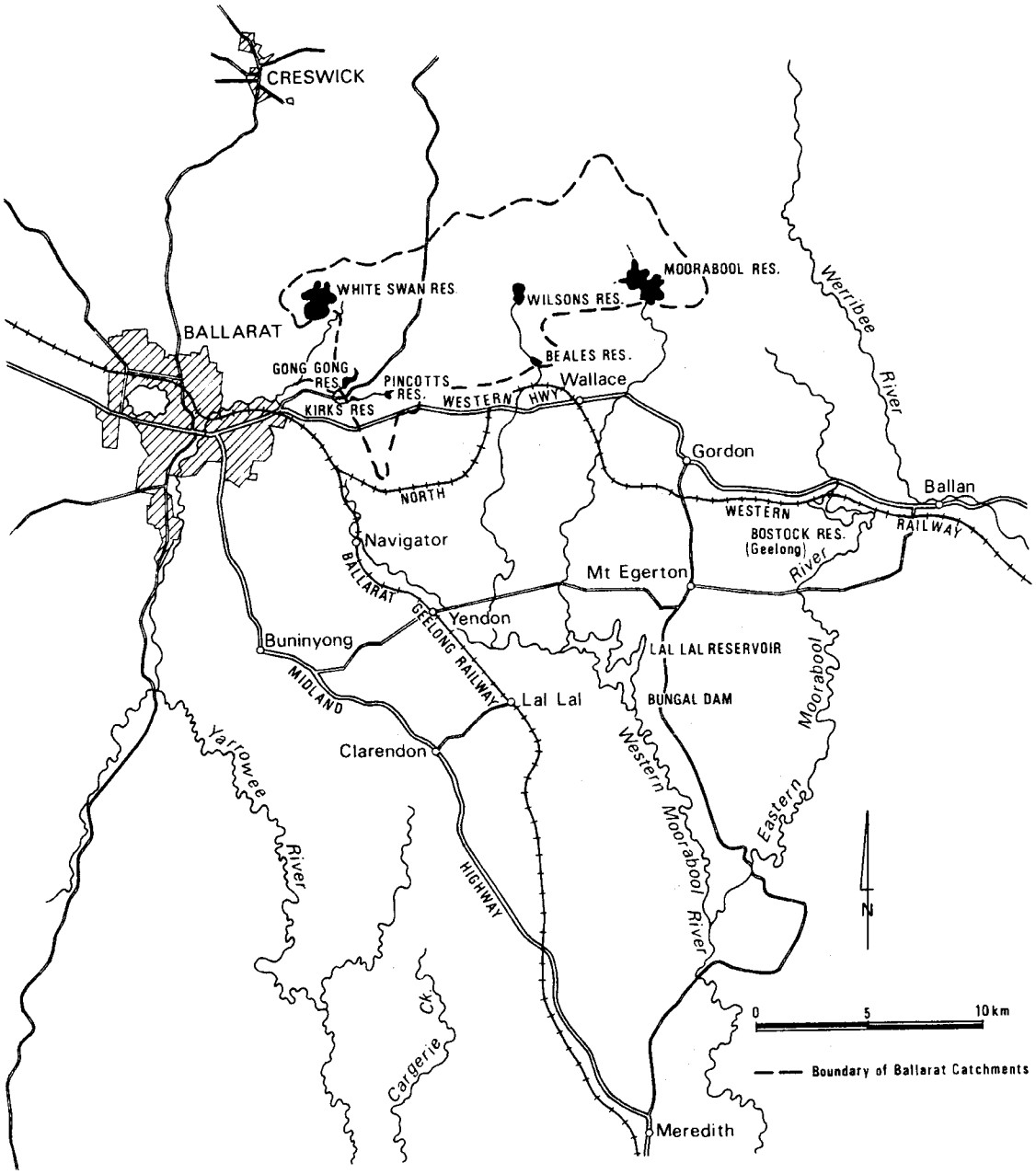


INTRODUCTION

The catchments to three of the reservoirs supplying Ballarat with domestic water lie in the northern part of the catchment to the Lal Lal Reservoir on the West Branch of the Moorabool River. Four other reservoirs supplying Ballarat are situated in the upper sections of the adjacent Yarrowee River catchment (see Figure 1).

The catchment to the Lal Lal Reservoir was proclaimed on the 6th June 1973, however the Ballarat Water Supply Catchments were excluded from this proclamation at the request of the Ballarat Water Commissioners.

The Ballarat catchments are bounded to the south by the proclaimed Lal Lal catchment; to the east by the Moorabool (She Oaks) catchment - proclaimed May 1978; to the north by the Creswick catchments - proclaimed June 1979; and also to the north by the Tullaroop catchment which will be recommended for proclamation during 1979. Over 75% of the Shire of Bungaree is covered by these catchments and a consistent approach to all the catchments would assist the shire when developing its planning policy. The shire is currently considering amendments to its Interim Development Order and it is hoped that these will include catchment protection measures.

The Ballarat Water Commissioners have maintained tight control over their catchments for many years; they have purchased critical areas of land adjacent to their reservoirs and incoming waterways wherever this land has become available. The Commissioners wish to ensure that their existing degree of control is either maintained or improved. In this situation a Land Use Determination is not seen as a high priority by the Soil Conservation Authority for at this time it would provide little or no additional control.

The Ballarat catchments fall within the land Conservation Water Council's Ballarat Study Area. The council's report for this area is currently in the course of preparation. It has been the Council's policy to recommend that where multiple use is required of a catchment supplying water used for domestic purposes, the catchment should be proclaimed under section 5(1) of the *Land Conservation Act* 1970 and section 22(1) of the *Soil Conservation and Land Utilization Act* 1958.

This report provides a brief description of the catchments for consideration by the Land Conservation Council so that they may recommend Proclamation of the catchments to the Governor in Council.

WATER SUPPLY AND QUALITY

Water Supply

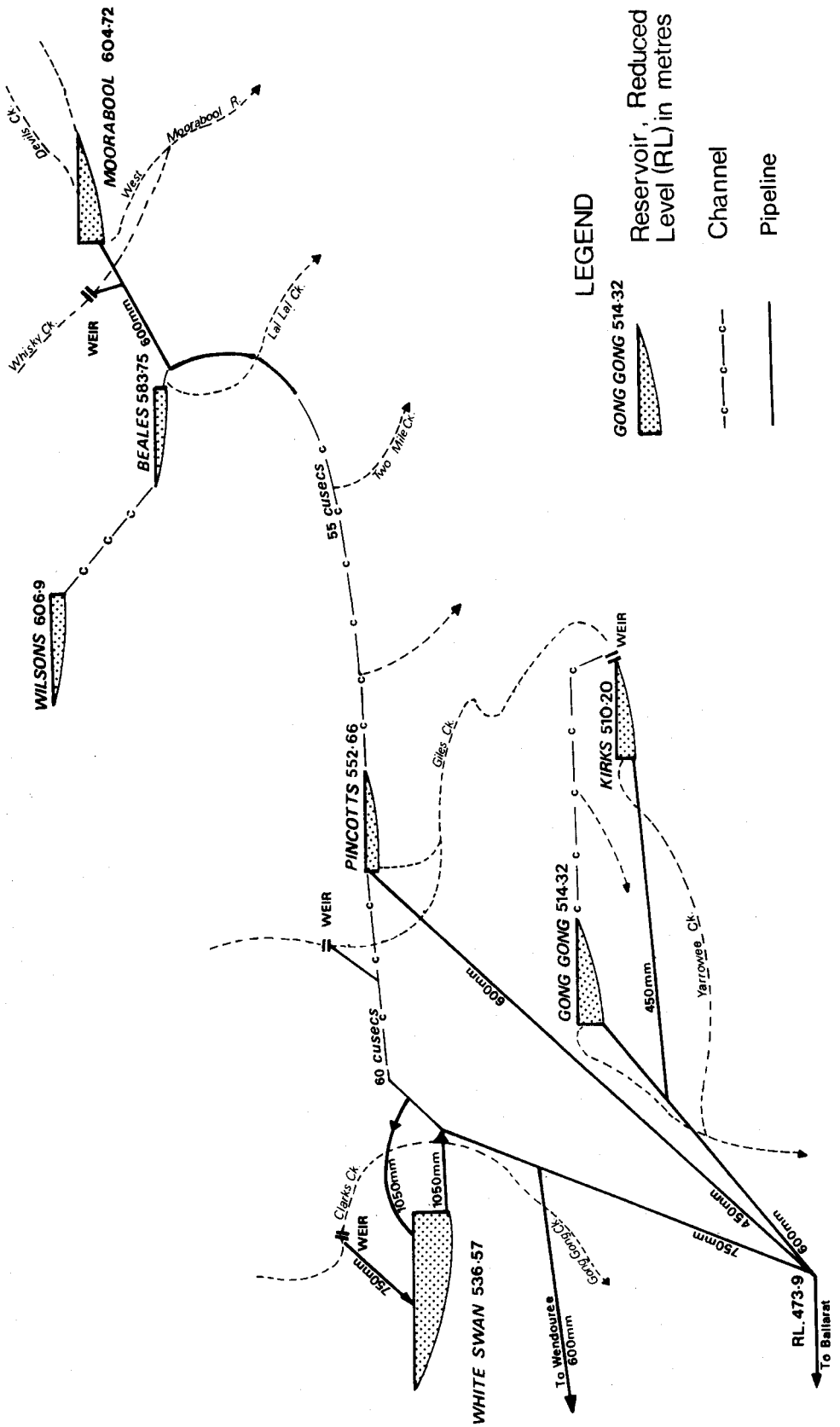
The Ballarat Water Commissioners were constituted on 1st July, 1880. The *Water (Amendment) Act* 1975, No. 8688 changed the representation on the Ballarat Water Commissioners to two Government appointees (4 year term), three representatives from the Ballarat City Council (3 year term) and one representative from each of the five surrounding municipalities (3 year term).

The Ballarat Water Commissioners supply a total population of approximately 70,000 (at December 1978) with an annual consumption of 13,000 ML. Of this total population, 4,400 people obtain their supply through other Water Supply Trusts as shown in Table 1.

Table 1 Water Supply Trusts obtaining water from Ballarat catchments

Trust	Approximately Annual Supply (ML)
Rokewood WWT	90
Buninyong WWT	120
Bungaree/Wallace WWT	85
Smythesdale/Scarsdale WWT	100
Linton WWT	154

Figure 2 Ballarat Water Catchment Storages - Schematic layout of System



The Ballarat Water Supply Catchments consist of seven separate reservoirs, as listed in Table 2, which have been constructed over the last century. Figure 2 illustrates schematically the layout of the supply system.

Table 2 Capacity of Reservoirs in the Ballarat Water Supply Catchments

Reservoir	Capacity (ML)	Height Datum of FSL (metres)
Wilsons	1013	606.92
Moorabool	6738	604.72
Beals	415	583.75
Pincotts	218	552.66
White Swan	14107	536.57
Gong Gong	1902	514.32
Kirks	400	510.20
TOTAL	24793	

1. Moorabool Reservoir (constructed 1915)

The Moorabool Reservoir is constructed on the upper reaches of the west branch of the Moorabool River at its confluence with Devil's Creek. Its capacity is 6,738 ML, and full supply level is at 604.72 m.

The catchment area is 3,026 ha, of which approximately 60% is forested and the remainder used for potato cropping and dairying.

A 600 mm pipeline from the outlet tower delivers water into the aqueduct south of Beales Reservoir. There is a diversion dam on Whisky Creek which can collect additional water from a 364 ha catchment in freehold ownership and divert it into the pipeline about 2 km, south of the Moorabool Reservoir. Over-flow from the Moorabool Reservoir flows into the Moorabool River and eventually into Lal Lal Reservoir (West Moorabool Water Board).

2. Wilsons Reservoir (constructed 1891)

Wilsons Reservoir is located on a small drainage line which eventually runs into Lal Lal Creek. It has a capacity of 1,013 ML at its full supply level of 606.92 m. Water is released from the Reservoir into Lal Lal Creek which has been brick lined and then runs into Beales Reservoir.

The catchment area is 841 ha of which the Ballarat Water Commissioners own approximately 500 ha. The remainder of the catchment is in freehold ownership and is used mainly for potato cropping.

3. Beales Reservoir (constructed 1863)

Downstream. of Wilsons Reservoir, Beales Reservoir releases water into an open aqueduct leading to Pincotts Reservoir. Because of the adjacent roadworks, section of this aqueduct has been replaced by pipeline. At a full supply level of Gong 583.75 m, Beales Reservoir has a capacity of 415 ML. It collects water from an additional 681 ha, most of it in freehold ownership and used for potato cropping.

The open aqueduct collects water along most of its length from, an additional 1569 ha, mostly in freehold ownership, except for a reserve along the route of the aqueduct.

4. Pincotts Reservoir (constructed 1867)

Water flows from the aqueduct into Pincotts Reservoir, which has a capacity of 218 ML at a full supply level of 552.66 m. The reservoir is located on Leigh Creek which drains the northern slopes of Mt. Warrenheip.

Water can be diverted from Pincotts Reservoir into, the Ballarat main, or to a stone lined natural watercourse into Kirk's Reservoir, or into Gong Gong Reservoir by a diversion weir and open channel, or by open channel and .pipeline into White Swan Reservoir.

5. Kirks Reservoir (constructed 1862)

Kirks Reservoir is a small terminal storage constructed on Giles Creek. Its capacity is 400 ML at a full supply level of 510.20 m. Apart from the natural catchment, Kirks Reservoir receives water from Pincotts Reservoir. The supply system at the four terminal reservoirs, White Swan, Kirks, Pincotts and Gong Gong, is designed to be as flexible as possible to select the best quality water, or to' allow a "shandy" mixture to be delivered to Ballarat.

6. Gong Gong Reservoir (constructed 1877)

Gong Gong Reservoir has a capacity of 1,902 ML at a full supply level of 514.32 m. It receives water from its own catchment and from the overflow from Pincotts diverted upstream of Kirks. The combined Kirks, Gong Gong and Pincotts catchments is 2,553 ha, mostly freehold, and used for grazing and potatoes apart from buffer areas owned by Ballarat Water Commissioners around the reservoirs.

7. White Swan Reservoir (constructed 1952)

White Swan Reservoir is the largest of the terminal reservoirs in the Ballarat system. It has a capacity of 14,107 ML at a full supply level of 536.57 m. The direct catchment to White Swan Reservoir is only 1,117 ha, most of it under the control of the Ballarat Water Commissioners and under a native forest cover. Clarkes Creek and Giles Creek can also be diverted into White Swan Reservoir. The main outlet points for surplus or poor quality water are:

(a) from the Moorabool Reservoir spillway and from the three floodgates on the main channel downstream of Beales Reservoir, all to Bungal Dam;

(b) water spilled to waste from spillways on Kirks and Gong Gong Reservoirs; a floodgate on the channel between Kirks and Gong Gong Reservoirs;

(c) in the case of turbid flows in Whisky Creek and Clarke's Creek, diversion is deferred for a few days until the quality improves. This water flows out of the system as follows:

* Whisky Creek - to Bungal Dam
* Clarkes Creek - to waste.

Present management uses the various options for the transfer of water to:

(i) keep the terminal reservoirs such as White Swan reasonably full;

(ii) keep the upper reservoirs' levels down to provide sufficient capacity to catch storm runoff;

(iii) keep storm runoff out of terminal reservoirs or diverted to reservoirs not being used for immediate supply;

(iv) retain as much water as possible in the White Swan - Moorabool system rather than incur the cost of pumping back from Bungal;

Water Quality

The Ballarat catchments are fairly intensively used for agricultural and other uses. The water quality consequently is not at all time ideal. The Ballarat Water Commissioners have actively pursued a policy of buying critical areas of land close to reservoirs and streams to help protect the water quality. The main water quality problems are algal growth, high iron concentrations, occasional undesirable turbidity and bacterial levels. Colour is also above desirable objectives on most occasions.

The five smaller reservoirs (Kirks, Gong Gong, Pincotts, Beales and Wilsons) are subject to periodic algal problems, including the growth of some algae responsible for tastes and odours in the water supply, e.g. anabaena, volvox, peridinium.

Phosphorus concentrations vary from 0.02 mg/1 to 0.05 mg/1, and with ample nitrogen available, phosphorus levels are high enough to support algal growth. It would be desirable to reduce phosphorus concentrations to less than 0.02 mg/1. As phosphorus tends to move with suspended sediment, some further controls on soil loss appear necessary. The Ballarat Water Commissioners consider nutrient concentration to be a major source of problems within the present supply system.

Turbidity during periods of high runoff averages about 20 FTU. Clarkes Creek and Fellmongers Creek cause high turbidity in White Swan Reservoir and Gong Gong Reservoir respectively.

The reservoirs act as settling basins and considerably improve the turbidity before water enters the reticulation system.

E. coli concentrations in the lower reservoirs during periods of high runoff have varied from 50 to 4000 orgs/100 ml. However, a change in the location of the inlet of raw water diverted to White Swan Reservoir is expected to considerably to reduce the maximum *E. coli* concentrations in the lower terminal reservoirs during periods of high run-off; also a reduction in ***E. coli*** level results from retention in the reservoirs. However in an untreated water supply the possibility of pathogenic bacteria or viruses entering the reticulation will depend to a large degree on the protection given to catchment land.

The possibility of road tanker spillages on the Western Highway and other roads poses a serious threat to the Ballarat supply. This threat, plus other contaminants from the Highway, have led the Commissioners to consider isolating Kirks and Pincotts Reservoirs and retaining them for emergency supplies only, but this is not yet possible.

A similar threat applies to the Gong Gong Reservoir from trafffic on the Daylesford Road.

Future proposals are that White Swan and Gong Gong Reservoirs should be the main terminal reservoirs for Ballarat, and Moorabool Reservoir the terminal reservoir for Bungaree and Wallace. These terminal reservoirs require increased catchment protection compared with the protection levels required for the non-terminal or emergency reservoirs.

The Commissioners have not yet obtained the level of protection they desire for Terminal Reservoirs.

CATCHMENT'DESCRIPTION

Geology

The Ballarat water supply catchments are bounded by Ordovician sandstones and siltstones in the west and east; the Quaternary basalt of the Central Highlands along the Great Dividing Range in the north; and the basalt flows to the south. The only other major geological material in the catchments is an area of Devonian granite around in Gong Gong Reservoir.

There are several large volcanic cones with varied lithology. Clarks Hill, Wombat Hill, Tipperary Hill and Mount Warrenheip (a breached scoria cone), are the most prominent of these.

The Ordovician sediments west of Muckleford Fault appear to be Lancefieldian, although the graptolite record is not complete for the Ordovician material around Ballarat East.

There are also small areas of Recent alluvium consisting of sands and gravels along the streams on which most of the Ballarat reservoirs are constructed.

Most of the area can be regarded as an upthrown fault block west of the Muckleford fault, which runs north-south past the Moorabool Reservoir. The older incised streams have been infilled by flows of volcanic lava, forming deep leads which were often found to be auriferous. The Great Dividing Range was several miles south of the existing Range before these volcanic eruptions. The deep leads mostly flow to the north, whereas the surface drainage is now to the south.

Physiography

The dominant features of the landscape in the catchments are the rolling Ordovician Hills in the east and west; the volcanic cones and their associated lava plains; and the lack of a defined drainage pattern through the plain.

The elevation range, drainage densities and relief of the major land systems in the catchments are given in Appendix 1.

Most of the surface drainage lines are not deeply incised, except in the steeper Ordovician sediments. There are several swampy areas and depressions in the basalt plain resulting from the poor drainage pattern. Small areas of stony rises also exist on the basalt plain.

Vegetation

Within the catchments the main areas still under native vegetation are the steeper Ordovician hills, and the areas surrounding the water supply reservoirs. The hill slopes have an open forest of *Eucalyptus viminalis* and *E. obliqua*, with *E. radiata* replacing *E. viminalis* on the crests and *E. ovata* replacing *E. viminalis* in the drainage lines. *E.* dives and *E. rubida* are also found in the steeper areas. One area near White Swan Reservoir has an unusual occurrence of *E. globulus* which has probably been introduced as the species is not endemic to the area.

Most of the basalt plains have been cleared of vegetation, but where remnants of the original open forest are found *E. viminalis, E. radiata* and *E. obliqua* are the dominant species. *E. ovata* is generally found in the poorer drained areas and along drainage lines.

The Devonian granite carries vegetation with similar characteristics to the rest of the plains vegetation.

Several areas have been cleared of native vegetation and *Pinus radiata* plantations established. The Ballarat Water Commissioners have purchased land around all of their reservoirs and along the aqueducts and have either planted these areas with *P. radiata* or leased them back to local farmers.

Soils

There is a clear relationship between the soils and land use within these catchments. The Ordovician sediments have mottled yellow, red gradational or red duplex soils with the soils tending to be more gradational and deeper with increasing rainfall. These soils have a high erosion hazard when disturbed and are generally used for forestry or grazing.

The basalt plains have two main types of soil; the red gradational (or krasnozemic type) or grey sodic duplex soils. The red gradational soils are well structured, fertile and well drained and are predominantly used for potato cropping. The grey sodic duplex soils tend to occur lower in the landscape. They are poorly drained, and difficult to cultivate, and are used mainly for grazing or occasionally for cereal crops.

Minor soils in the catchment are the mottled yellow, red duplex soils on granite; the black uniform soils in drainage lines and depressions on the basalt; shallow stony gradational soils on the hill crests; and brown uniform soils and yellow duplex soils along the river terraces. All of these soils are used for grazing or forestry.

Land Systems

In "A Study of Land Capability in the Shire of Bungaree" (Jeffery, et. al., 1979), twelve land systems were described and rate for four kinds of residential use. All of these land systems except for "Qap" occur in the Ballarat water supply catchments.

The distribution and dominant land features of these land systems is given in Appendices 2 and 3. For details of individual land systems the reader is referred to the original report.

CLIMATE

The Ballarat water supply catchments lie on the south side of the Great Dividing Range to the north-east of Ballarat. The climate is best described as cool and moist, being generally colder and wetter than Ballarat.

Temperature
The nearest recording station is at Ballarat at an elevation of 437 m. Average daily mean temperatures for February is 18.2°C and for July 6.7°C, the warmest and coldest months respectively. Average daily maximum, minimum and mean temperatures for each month are given in Appendix 4.

Frosts
Ballarat has an average of about 12 severe frosts and an additional 22 light frosts each year. In the catchment area the number of frosts would be greater.

Rainfall
Rainfall records are kept for several of the Ballarat Reservoirs, where the average annual rainfall recorded is approximately 25% higher than at Ballarat.

Average annual rainfall for these stations published in 1956 for 30 years of records was:

Ballarat 710.6 mm	
Beals Reservoir	892.3 mm
Kirks Reservoir	818.6 mm
Moorabool Reservoir	857.8 mm

A table showing the comparison between average monthly and average annual rainfall at the four sites is given in Appendix 5.

Additional data from the Ballarat Water Commissioners 1976 Annual Report for a longer period of record to 1976 shows that annual averages are from 2-9% higher, indicating wetter years since 1956. Data from the report states the annual average rainfall for White Swan Reservoir is 87-4.2 mm, and for Wilsons Reservoir is 882.6 mm.

The "runoff" yield from. the total catchments area of 10,150 ha is approximately 28.2% of the average annual rainfall, or 25,963,000 m^3. The high "runoff" percentage reflects the generally moist catchment conditions rather than impermeable or hard surface soils in the catchments. Rainfall is fairly evenly distributed throughout the year, and there is a better than 60% probability of receiving more than 25 mm of rain in any month of the year. The reliability of rainfall makes the area ideally suited for a water supply catchment and also for agriculture.

Snow
Occasional snowfalls occur in the catchment and are most frequent in August and September. At Ballarat, snow has been. recorded in six out of ten years in these months.

Growing Season
Effective rainfall in the catchment is available for about 11 months, but the growing season is reduced by low temperatures during June, July, August. The frequency of summer droughts is less than 10%.

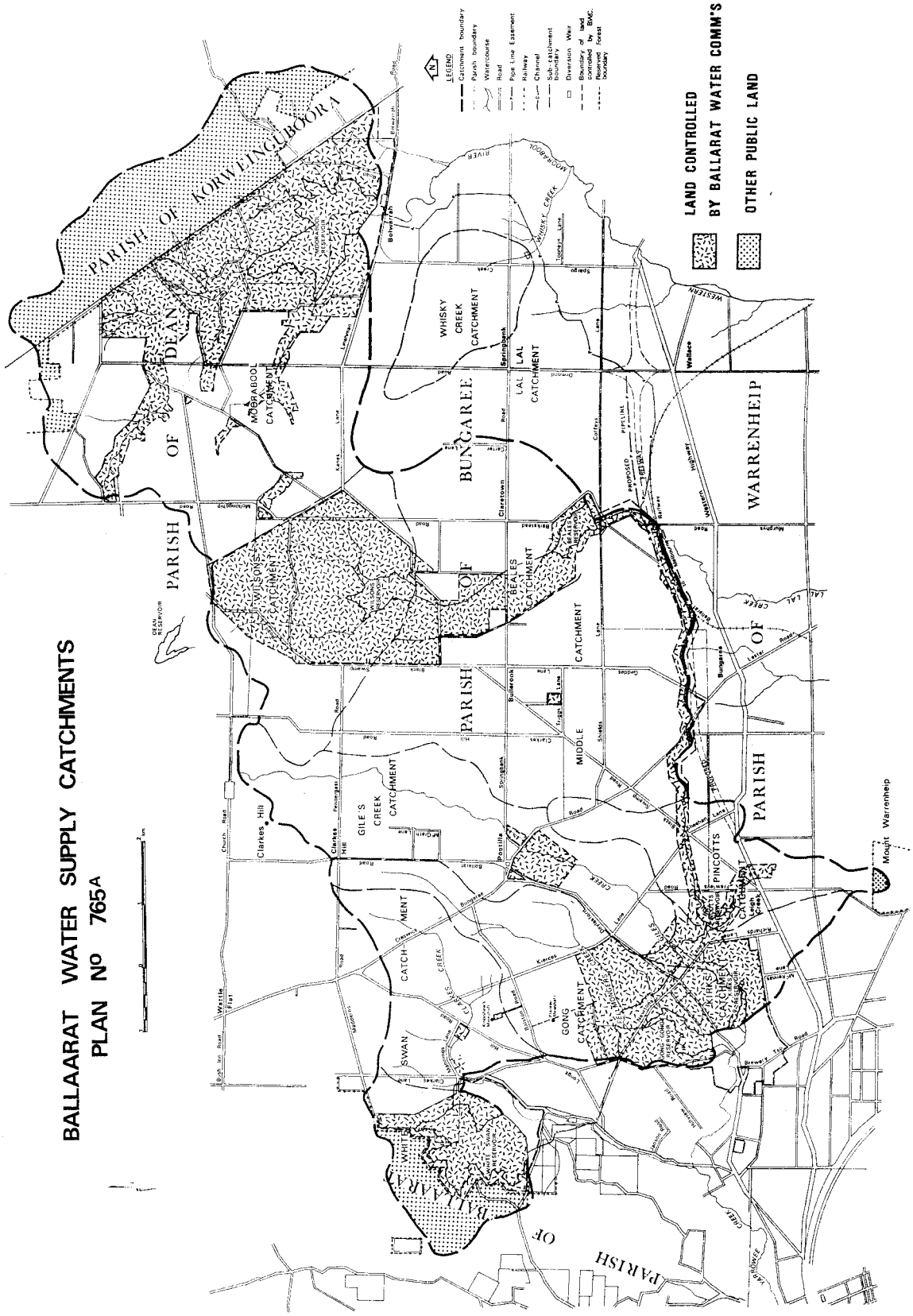
LAND TENURE & LAND USE

The total catchment area to all storages offtakes and open channels is approximately 10,150 ha.

The Ballarat Water Commissioners have approximately 1240 ha under Crown grant; 160 ha in Crown Reservoir Reserves; and 1465 ha under freehold title. Approximately 390 ha consists of the surface area of the reservoirs.

Approximately 600 ha in the north east of the catchment (in the catchment to Moorabool Reservoir) is part of the Wombat Reserved Forest and 125 ha in the west (in the White Swan catchment) is part of the Creswick State Forest.

Figure 3 Land Tenure



The remainder of the catchment is predominantly in freehold ownership.

The Ballarat Water Commissioners have both hardwood and softwood plantations which produce timber of commercial value. They have their own softwood timber mill and box factory situated on freehold land below Kirks Reservoir. Pulping grade timber which cannot be handled by the mill is sold privately.

The Commissioners lease back land approximately 615 ha to farmers when it is considered that agricultural use of the land poses no threat to water supply interests. The conditions of the leases include:

1. A five-year term, renewable at the discretion of Ballarat Water Commissioners.

2. Restriction on stock and domestic animals.

3. A distinction between cultivated land and bush land.

4. No successive crop on the same area of land.

Revenue from the leases is approximately $35,000 per year.

The Ballarat Water Commissioners have also developed very attractive picnic reserves for the public around several of their reservoirs. This development is restricted to areas downstream of terminal reservoirs.

Figure 3 shows the current tenure of land including that owned by the Ballarat Water Commissioners.

Agricultural uses in the catchment are largely governed by soil type. The red gradational basaltic soils are used for potato cropping. The grey duplex soils on basalt support cereal cropping and grazing.. The soils on the Ordovician hills are mainly suited to grazing or forestry. There are several dairy farms in the catchment.

Recreational uses are also increasing in the catchment. Kryal Castle and a proposed Tudor Village on the slopes of Mt Warrenheip are the most significant of these.

The catchment area has not been subject to many significant changes in land use over the recent past; a factor which suggests there is no immediately need for a land use determination.

Rural statistics giving the area, number and production from farm holdings within the Parish of Bungaree for the period 1969/70 to 1975/76 are given in Appendix 6.

PLANNING CONTROLS

All of the catchment is in the Shire of Bungaree which has a fairly detailed Interim Development Order. The IDO includes a Public Purposes (water supply protection) Zone but includes only that land already owned and controlled by the Commissioners along the aqueducts and around the reservoirs; a Rural Highway Zone along the Western Highway; and a Rural Zone in which the minimum subdivision area is 16 ha.

The Shire is currently considering amendments to the IDO to fit in with the Ballarat Planning Scheme and the proposed Land Use Determination for the Lal Lal Catchment. The Town and Country Planning Board is to assist the Shire in carrying out these amendments.

The Ballarat Water Commissioners are consulted on planning matters within the catchments. They have prepared a plan incorporating their requirements in regard to zoning catchment areas within the proposed Shire of Bungaree Planning Scheme. The main features of this, given in Appendix 7, are not incorporated in the Shire's Interim Development Orders.

The West Moorabool Water Board has some control over the catchment to Bungal Dam (which includes the catchments to Moorabool, Beales and Wilsons Reservoirs). Their control is limited and in the form of a veto power in that they may refuse to consent to the sealing of plans of subdivision which are considered to be a hazard to the water supply.

In regard to planning, the requirements of the Board are the same as those for the Ballarat Water Commission shown in Appendix 7.

The Land Conservation Council is currently studying the public land in this area and will make recommendations for use of that land (including land controlled by the Ballarat Water Commissioners) in the near future.

HAZARDS TO THE WATER SUPPLY

The main types of pollution which could affect the Ballarat water supply are as follows:

Pathogens
Stocks and domestic effluents containing pathogenic bacteria and viruses may enter the water supply at many points in the catchments. None of these catchments are completely closed to this possibility, although White Swan Reservoir is the best protected in this regard. However, to date, the water supply has never been identified as a source of infection.

Nutrients
Most of the catchments have soils of high physical fertility but of low chemical fertility, requiring heavy inputs of fertilizer especially for potato cropping. Nutrient concentrations in the stored waters are high enough to cause infrequent algal blooms. These algal blooms reduce the oxygen content of the water and, if treated with chlorine, will cause tastes and odours and may release toxins. The reduced oxygen content may precipitate iron which can discolour the water and stain washing. The toxins may pose a health threat.

Toxicants
The potential exists for pesticides and weedicides to enter the water from cropping and other agricultural enterprises. Spillage of toxic material from an accident on the Western Highway is an ever-present threat to Pincotts and Kirks Reservoirs, as it is to Gong Reservoir from the Daylesford Road. Lead and other waste products from traffic may also enter the water supply from these sources.

Sediment
Turbidity and suspended sediment are commonly present in run-off after storms. Fortunately the supply system allows a fair amount of detention and better quality water can be diverted into the reticulation. Sediment carries nutrients and other pollutants into the water supply.

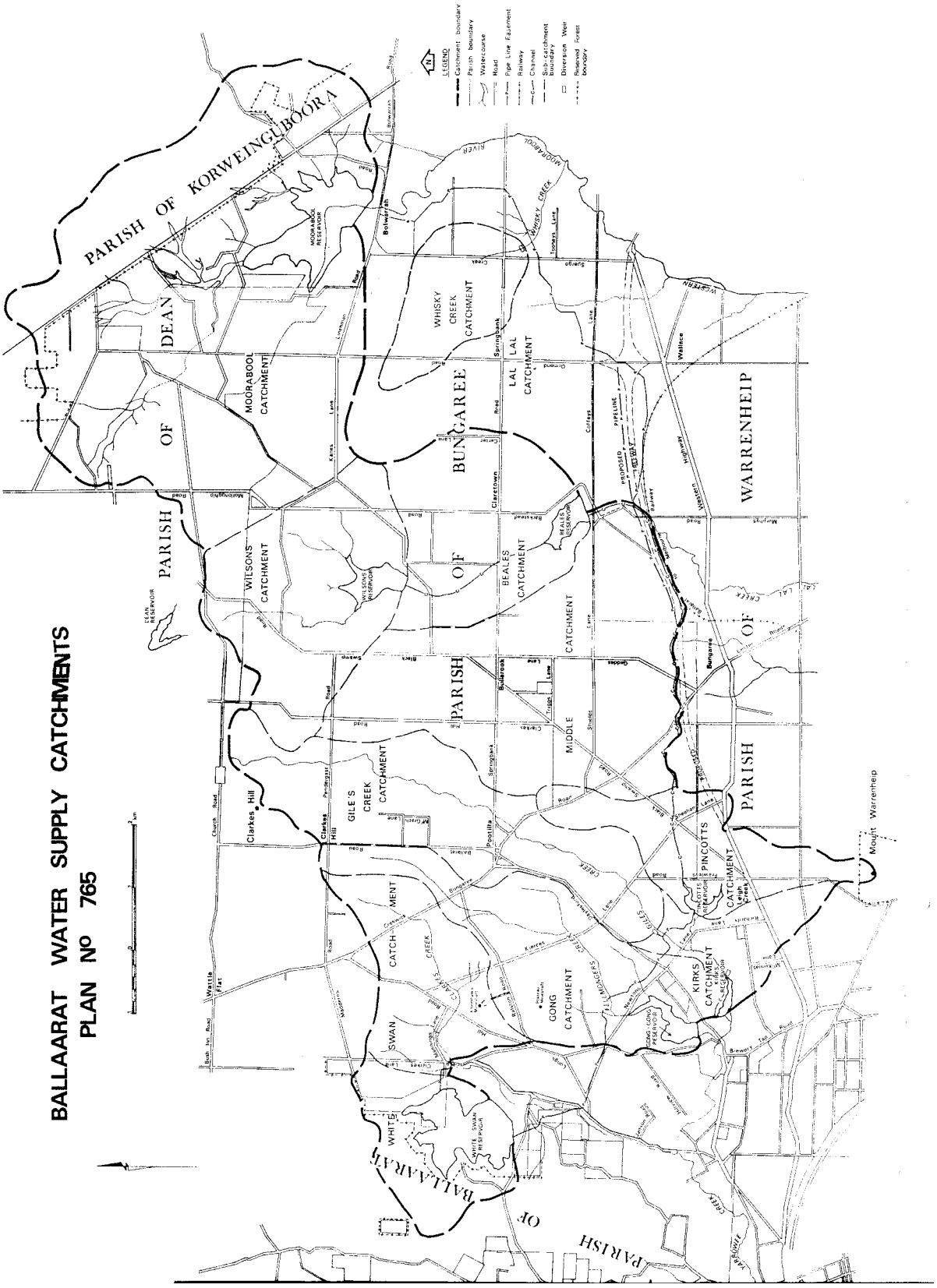
Metals
Concentrations of heavy metals present have all been satisfactory except for iron which could lead to tastes and discolouration in the reticulated supply. Iron concentrations build up in the reservoirs unless special measures are taken to drain off water with a high iron concentration. Mercury and lead are two other potential problems which fortunately are no cause for concern at present.

RECOMMENDATIONS

(a) That the Authority approves this report and forwards it to the Land Conservation Council for consideration.

(b) That the Land Conservation Council recommends to the Governor-in-Council that the Ballarat Water Supply Catchments, as shown on Figure be proclaimed under Section 5 (1)(b) of the *Land Conservation Act* 1970 and Section 22 (1) of *the Soil Conservation and Land Utilization Act* 1958.

Figure 4 Catchment Plan



APPENDIX 1

Table 3 Elevation range, drainage, densitites and relief of land systems in the Ballarat Water Supply Catchments

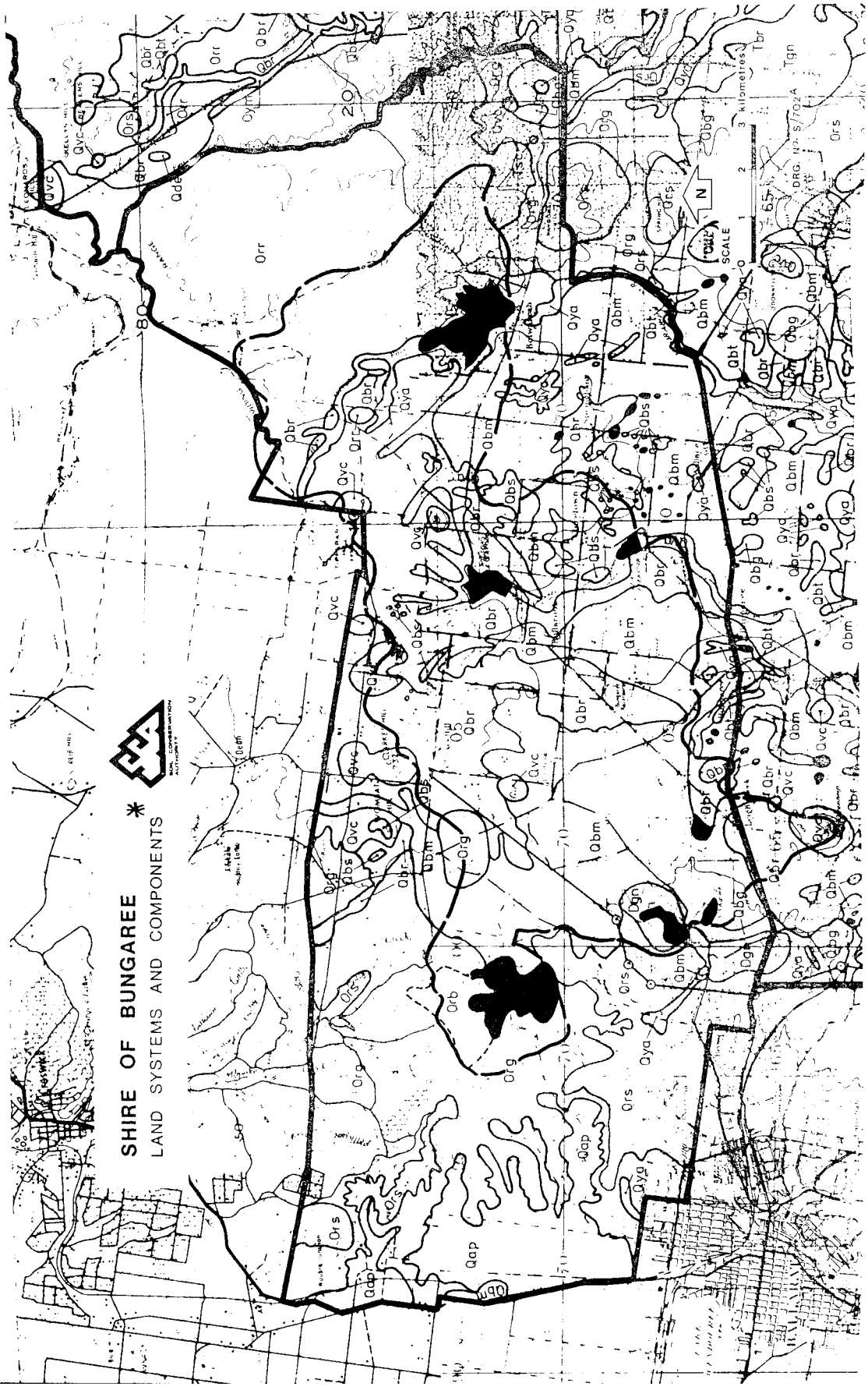
Land System	Elevation Range (m)	Local Relief (m)	Drainage Density (km/km^2) & Pattern
ORB	420	10	3.9 Dendritic
ORR	670	45	5.9 "
ORG	420	10	3.9 "
ORS	425	65	7.6 "
QYA	320	2	3.3 -
QBG	482	2	2.2 Dendritic
QBM	280	4	2.3 "
QBR	660	5	1.6 "
QBS	500	1	Nil
QVC	600	60	- Radial
DGN	520	30	4.8 Denmdritic

*Table 4 - Dominant Features of the Land within the Shire of Bungaree**

Map Symbol	Area km²	Area %	Average annual rainfall mm	Geology	Landscape	Native vegetation	Soils	Forms of soil deterioration
QBM	53.9	25.2	850-950	Pleistocene basalt	Slightly dissected plains	Open forest: E. viminalis, E. obliqua, E. radiata	Red gradational soils, fine structure, dark red gradational soils, fine structure, mottled yellow sodic, duplex soils, coarse structure	Sheet & wind erosion, nutrient decline, compaction
QBR	34.5	16.2	940-950	Pleistocene basalt	Undulating plains	Open forest: E. viminalis, E. radiata, E. obliqua	Red gradational soils, fine structure	Sheet & wind erosion, nutrient decline
QAP	10.5	4.9	660-711	Quaternary alluvium, colluvium	Plains	Open forest: E. ovata, E. obliqua, E. melonoxylon	Yellow mottled, red gradational soils, (Variable)	Compaction
QYA	7.4	3.4	650-900	Quaternary river deposits, gravels, sands & clays	Alluvial terraces	Woodland: E. viminalis, E. radiata	Dark brown soils, uniform texture, (Variable)	Stream-bank erosion, gully erosion
QVC	3.3	1.5	600-950	Quaternary basalt, scarps, tuffs	Scattered volcanic cones	Open forest: E. viminalis, E. radiata	Stony red gradational soils	Rill & sheet erosion, nutrient decline
QBS	1.5	0.17	810-840	Pleistocene basalt	Stony rises	Woodland: E. viminalis, E. obliqua. E. radiata, E. ovata	Red shallow stony gradational soils	Sheet erosion
QBG	0.5	0.2	650-900	Pleistocene basalt	Slightly dissected plains	Open forest: E. ovata, E. viminalis, E. rubida, E. obliqua	Mottled yellow, grey sodic duplex soils, coarse structure	Surface compaction, sheet erosion
DGN	2.5	1.1	765-770	Devonian granite, granodiorite, quaternary wash	Rolling plains	Open forest: E. ovata, E. obliqua, E. radiata, E. viminalis	Mottled yellow red duplex soils	Rill & gully erosion, compaction
ORR	38.2	17.8	900-950	Ordovician slates & sandstones, quaternary basalt	Hills	Open forest: E. obliqua, E. radiata, E. rubida, E. dives, E. viminalis	Yellow gradational soils, fine structure, shallow stony brown gradational soils	Sheet & rill erosion, nutrient decline
ORG	36.5	17.2	650-900	Ordovician slates & sandstones	Slightly dissected plains	Open forest: E. viminalis, E. obliqua, E. ovata	Mottled yellow red duplex soils	Sheet, rill & gully erosion, compaction
ORS	16.4	7.7	760-810	Ordovician slates & sandstones	Steep hills	Woodland: E. obliqua, E. dives, E. radiata	Mottled yellow red gradational soils, fine structure, shallow stony red gradational soils	Sheet & rill erosion, compaction
ORB	1.9	0.9	750-780	Ordovician slates & sandstones	Slightly dissected plains	Open forest: E. viminalis, E. obliqua, E. globulos, E. radiata	Mottled yellow red gradational soils	Sheet, rill & gully erosion, compaction
Reservoirs	6.8	3.2						

* Source: A Study of Land Capability in the Shire of Bungaree Soil Conservation Authority (1979)

Figure 5



*Source: A Study of Land Capability in the Shire of Bungaree Soil Conservation Authority (1979)

APPENDICES 4 & 5

Table 6 Temperature Data for Ballarat*

	J	F	M	A	M	J	J	A	S	O	N	D
Av. Daily Max. ^{o}C	24.3	24.9	22.0	17.2	13.5	10.2	9.9	11.3	13.9	16.9	19.7	22.5
Av. Daily Min. ^{o}C	10.2	11.6	10.0	7.6	5.9	4.1	3.5	4.1	5.1	6.4	7.8	9.6
Av. Daily Mean ^{o}C	17.2	18.2	16.0	12.4	9.7	7.2	6.7	7.7	9.5	11.7	13.7	16.0

Table 7 Average Monthly and Average Annual Rainfall (mm) for stations at Ballarat and within the Catchments*

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Ballarat	33.0	46.0	45.7	54.6	62.2	67.8	70.1	76.7	74.4	64.8	54.9	60.4	710.6
Beales Reservoir	40.9	54.3	55.4	69.3	81.5	88.4	89.7	101.3	93.7	82.8	67.1	67.8	892.3
Kirks Reservoir	37.8	47.5	51.8	64.8	73.7	82.8	81.8	90.7	85.9	74.9	62.0	65.0	818.6
Moorabool Reservoir	43.9	47.2	51.6	66.2	78.7	87.4	91.7	99.1	89.2	83.1	62.0	57.7	857.8

* Source: Resources Survey - Central Highlands Region. Central Planning Authority (1956)

APPENDIX 6

Table 8 Rural Statistics for the Parish of Bungaree

	1969/70	**1975/76**
Area of Farm holdings (ha)	8545	9072
Number of holdings	123	110
Average size of farm holding (ha0	69.5	82.5
Area of sown pasture (ha)	4587	4090
Area of native pasture (ha)	1136	1343
Area of wheat (ha)	327	253
Area of barley (ha)	114	297
Area of oats (ha)	238	505
Area of vegetables (ha)	859	636
Number of cattle	4086	6272
Number of pigs	261	359
Number of sheep	26370	20890
Wool clip (kg)	54866	72112

APPENDIX 7 - PLANNING PROPOSALS FOR BALLARAT WATER SUPPLY CATCHMENTS PROPOSED BY THE BALLARAT WATER COMMISSIONERS

1. Special Uses - Water Supply

Land controlled by the Ballarat Water Commissioners for water supply purposes.

Access and usage controlled by the Ballarat Water Commissioners.

2. Zone 1

Land which is required to be zoned for water supply protection purposes. The area shown hatched is required under this category, but if funds become available for proposed engineering works in the future, it may be possible to reduce the areas included in this zone.

To be Prohibited - Subdivision of New Buildings
- Orchards
- Industry
- Bee Keeping
- Rubbish Disposal
- Quarrying
- Mining
- Intensive Animal Husbandry -
  - Piggeries
  - Feedlots
  - Dairies
  - Poultry
- Cultivation, etc.
- Any other activities except those specifically permitted.

To be Permitted - Light Grazing
- Forestry

3. Zone 2

Land which drains directly to terminal reservoirs or to channels, which feed terminal reservoirs and generally within about two miles of the top water line of these reservoirs and channels leading to hem.

To be Prohibited - any New Piggeries (existing to be phased out)
New Poultry Farms (existing tolerated)*
- New Dairies (existing tolerated)*
- Feed Lots
- Rubbish Disposal
- Industry
- Urband Development (Houses) - even on existin farms unless replacing existing homes
- Subdivision to create allotments less than 16 hectares.

4. Zone 3

Land which comprises the balance of catchment area.

Urban Development should only be permitted at existing centre of:

Wallace and Bungaree (shaded brown and hatched on the plan) and should be limited to the smallest possible extent, preferable to areas which could foreseeably be sewered in the future.

Elsewhere, the following conditons should apply.

To be Prohibited - any New Piggeries (existing tolerated)*
Feed Lots
Rubbish Disposal
Industry
Subdivision to create allotments less than 16 hectares except that:

Owners of any allotment on which there were two or more dwelling houses existing uner construction at 1st July, 1973, could be permitted to create allotments of not less than one acre in area provided that each allotment so created contained at least one such dwelling house. An allotment means a parcel of land for which only one title can be issued.
This means that any allotment containing say three dwelling houses at 1st July, 1973, will be permitted to be divided into a maximum of three allotments provided that each allotment contains at least one of the houses and exceeds one acre in area.

To be Permitted - Poultry Farms*
Dairy Farms*

* Subject ot Adequate Controls.

Figure 6 Planning Proposals