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# WATER RESOURCES

## WATER RESOURCES AND THEIR CONTROL

### Introduction

Average annual rainfall varies widely from place to place throughout the world. Within Australia it varies from 3,201 mm near Innisfail in northern Queensland to less than 102 mm in the north-east corner of South Australia. Within Victoria it ranges from 2,032 mm in the eastern Alps to 254 mm in the arid north-west. Broadly speaking, the main factors that influence rainfall are elevation and nearness to the coast. Evaporation tends to vary oppositely. Consequently the sources of major rivers in Australia are concentrated in relatively narrow zones of high relief bordering the coast.

The seasonal patterns of streamflow, and its reliability from year to year, also vary widely from place to place, affecting the usability of the transitory local surface supplies of fresh water. Average annual rainfall over the State of Victoria as a whole is about 432 mm. The area of the State is 22,761,851 hectares. Total precipitation is, therefore, about 98 million megalitres. Only 49 million megalitres appear in the average annual flow of Victorian river systems. It is not known as yet how much of the remainder soaks underground to recharge groundwater resources, but this will be elucidated by a long-term programme of investigation being carried out by the Victorian Mines Department.

Groundwater resources move slowly through pores and cracks in soil and rock, and respond sluggishly to seasonal and annual fluctuations in recharge. For this reason, groundwater can be regarded as a generally more reliable source of water through drought periods. However, mapping of resources in terms of depth, yield and quality is much more complex than the mapping of visible surface resources. The present picture, very broadly stated, is that there are groundwater resources of reasonable quality and yield for domestic and irrigation purposes over about one sixth of Victoria, mainly in the far west and south-west and in alluvial valleys in the north and the south-east. On the other hand, for about half Victoria's area, in the central and western sectors, groundwater is generally not available at qualities better than 3,000 parts per million of total dissolved solids.

Groundwater has played a very important part in providing supplies of water for domestic and stock use in pastoral settlement. It is also used for some isolated town supplies, and is being increasingly used for irrigation, the area irrigated from groundwater now being about 12,200 hectares. For the future, there are prospects of generally increased use for irrigation, and for the augmentation of town water supplies on the south-west coast, in the Barwon valley, and in Gippsland. These prospects can be clarified, however, only by continuing investigation.

In the foreseeable future, Victoria will continue to depend mainly on surface water resources, and these resources are unevenly distributed in both space and time. Their distribution in space can be conveniently described by considering Victoria as being divided into four segments by an east-west line along the Great Dividing Range and a north-south line through Melbourne.

The north-west segment contains 40 per cent of Victoria's area, the other three segments 20 per cent each. Surface water resources, represented by average annual river flow, are heavily concentrated in the eastern segments, each accounting for about 40 per cent of the total. The western segments account for only 20 per cent of total flow, with only 3 per cent in the north-west segment. Quality of stream flow also deteriorates from east to west. Waters of the eastern rivers mostly contain less than 100 parts per million of total dissolved solids. In the western rivers the figure is generally above 500 parts per million, except near their sources, and increases downstream to figures in excess of 1,500 parts per million.

River flows in Victoria exhibit a marked seasonal pattern and marked variability in annual flow from one year to another. Over the State as a whole, about 60 per cent of average annual flow is accounted for in the four months July through October. In western streams this percentage approaches 75 per cent. Everywhere, flows typically recede in the summer and autumn, at the time of year when water requirements for most uses are at a peak. Annual flow in wet years is commonly more than twice the annual average, and in dry years commonly less than half the average. Dry years and wet years succeed one another almost at random but runs of dry years occur unpredictably from time to time. Even on a relatively reliable stream such as the Ovens River at Wangaratta there have been five occasions in the past 80 years when the total flow over two successive years has been less than the average one year flow, and two occasions when the total flow over three successive years was only one and a half times the average one year flow.

### Ministry of Water Resources

During the summer of 1973 the Melbourne metropolitan area was faced with a serious water shortage because of a prolonged dry spell of weather. To advise the Government on steps to overcome the emergency at that time and to plan future water conservation works, a Standing Committee consisting of representatives of the State's two major water authorities, the State Rivers and Water Supply Commission, and the Melbourne and Metropolitan Board of Works, and a representative of the Treasury, was appointed. The work of the Committee emphasised the desirability of having a co-ordinating body for Victoria's water resources, and the Government decided to give it statutory authority within a proposed new Ministry—the Ministry of Water Resources.

As part of the Ministry, there will be a Water Resources Council which will include the same representation as the Standing Committee, and whose Chairman will also be Director of Water Resources, with appropriate staff to enable the Ministry to perform a co-ordinating function in assessing and developing Victoria's water resources including the extension and development of sewerage and drainage services.

The proposed Ministry will make possible the long range planning of future requirements, especially for additional decentralised urban complexes and will also enable a proper balance to be achieved between rural, urban, and industrial development. The Ministry will also be able to advise the Government on priorities for construction.

The legislation will not change in any way the functions of either the State Rivers and Water Supply Commission or the Melbourne and Metropolitan Board of Works, but will implement the Government's policy

of bringing both bodies under a single Ministry to enable the co-ordination of their activities. (The work of the Melbourne and Metropolitan Board of Works is described on pages 192-203.)

### State Rivers and Water Supply Commission

The State Rivers and Water Supply Commission was constituted under the Water Act passed by the Victorian Parliament in 1905 and was made responsible for the conservation and distribution of rural water resources and the control of the use of water from rivers and streams and other natural sources with the exception of the area controlled by the water supply authority for the metropolis of Melbourne.

The establishment of the Commission followed earlier attempts to set up a body to manage Victoria's water resources. The Irrigation Act of 1886 provided a solid foundation for the development of water supply and irrigation that followed its effective nationalisation of all surface waters of Victoria, whereby the right to the use and control of waters in every river, creek, stream, billabong, lake, lagoon, swamp, and marsh was vested in the Crown. The Act also provided for the establishment of irrigation trusts with financial advances from the Government to meet the cost of irrigation works and for certain headworks to be constructed by the Government. The earliest of these headworks were the Goulburn Weir near Murchison and the Laanecoorie Weir on the Loddon River. The irrigation trusts proliferated and within a few years spread throughout Victoria, but failed because of the lack of large storages to provide a reserve water supply in dry seasons, and a lack of readiness by landholders to make appropriate use of water when it was available.

Since the establishment of the State Rivers and Water Supply Commission in 1905, three Commissioners, appointed by the Governor of Victoria, have managed its activities. The Commission employs a permanent work force of some 1,700 people throughout Victoria and up to 2,000 temporary personnel according to the demand for labour on Commission works. Of the total permanent staff employed (1,700) about 500 are engaged on engineering, surveying, drafting, and other professional occupations, about 550 on water distribution, district operations, and maintenance, and about 550 on accounting and administration duties. In addition, a day labour force of 1,700 is employed, 600 being engaged on construction projects and 1,100 on district maintenance.

More than 40 large storages, 320 subsidiary reservoirs, and 30,000 kilometres of channels and pipelines are operated by the Commission to supply water for irrigation, stock, and domestic purposes, and for reticulated town supplies. In addition, the Commission provides water supply for domestic, stock, and industrial purposes in an area of rural and urban lands totalling about 5,000,000 hectares. It also administers flood protection, drainage, and river improvement works throughout Victoria. Annual delivery of irrigation water was 1,735,669 megalitres for 1973–74.

The Commission's engineering functions are divided into the following three main branches each under the control of a Chief Engineer: major works—investigation, survey, design, and construction of major projects; rural water supplies—operation and maintenance of irrigation, drainage, and flood protection districts; and town water supplies—construction, operation, and maintenance of urban water supplies, as well as engineering and financial supervision of local authorities for water supply, sewerage, and river improvement. All of these works were designed and constructed, and are operated and maintained, by the Commission. Specialised services to these branches are provided by the mechanical, finance, accounts, stores, staff, estates, valuations, and secretarial branches.

The Commission supplies reticulated domestic and industrial water to 148 towns with a total population of 300,000, and supervises the supply of a further

259 towns through local authorities. It also supervises the engineering and financial activities of 77 sewerage authorities and 27 river improvement trusts.

The Commission has also developed, patented, and arranged for the manufacture under licence of small control structures, both of manual and automatic operation, for use on farm (terminal) channels.

Since 1969 the Commission has been providing assistance to the Awash Valley Authority in Ethiopia under the Food and Agriculture Organisation (FAO) of the United Nations. The task of this project is to assist the Awash Valley Authority in the development of the water and agricultural resources of the Awash River basin.

Major water supply projects completed between 1967 and 1974 included:

| Project | Features |
|---|---|
| Lake William Hovell | Earth and rockfill dam, storage 12,330 megalitres |
| Lake Nillahcootie | Earth and rockfill dam, storage 39,790 megalitres |
| Lake Merrimu | Earth and rockfill dam, storage 19,140 megalitres |
| Merrimu Tunnel | Tunnel 2 kilometres long, 2.3 metres diameter |
| Campaspe Irrigation and Drainage District | 9,000 hectares |
| Barr Creek Salinity<br>Lake Hawthorn Salinity | Salinity control on Murray River |
| Pyramid Creek and Broken Creek | Improvement by dredging of 130 kilometres of natural watercourse used as major supply and drainage carriers |
| Lake Mokoan | Earth and rockfill off-river storage, capacity 364,800 megalitres |
| Lake Rosslynne | Earth and rockfill dam, storage 24,700 megalitres |

Major projects under construction in 1975 were:

| Project | Features |
|---|---|
| South Otway | 55 kilometres concrete-lined mild-steel pipeline of 500 mm diameter |
| Dartmouth Dam | Earth and rockfill dam, storage 4,000,000 megalitres |
| Tarago–Western Port | 65 kilometres concrete-lined steel pipeline of 1,100 mm diameter |
| Merrimu Second Stage Tunnel | Tunnel 3.2 kilometres long, 2.3 metres diameter |

Other services for which the Commission is responsible cover irrigation and agricultural extension work, including surveying, irrigation land layout, surface and underground drainage layout, salinity control; and licensing and control of diversions from rivers and streams and from underground resources throughout Victoria.

*Finance*

Acting as a government authority, the Commission constructs its works with funds provided for the purpose by the Victorian Parliament, amounting to $385m by 30 June 1974, including contributions by Victoria towards works carried out for the River Murray Commission. A further $95m of government loan moneys has been provided for expenditure by local authorities under the supervision of the Commission. In recent years the rate of expendi-

ture on construction of State works has been about $20m annually, and the Commission also supervises the expenditure of about $5.5m annually by local authorities.

The Commission administers, supplies water to, and collects revenue from nearly 110 separate districts, each of which is administered financially as a separate undertaking. Revenue for 1973–74 from its ten irrigation districts exceeded $7m; from its urban districts $4.3m; from its thirteen rural and waterworks districts $2.2m; and from its three flood protection districts $115,000. The total annual revenue for 1973–74, including other sources, was $17m.

### *Groundwater Act*

The Groundwater Act, which was proclaimed in September 1970, enabled the Victorian Mines Department and the State Rivers and Water Supply Commission to establish the administrative procedures necessary for the investigation, conservation, and utilisation of the groundwater resources of Victoria. The Act gives the Mines Department authority to investigate the State's groundwater resources so that total water resources and their proper use can be considered by the Government in the future.

Since the proclamation of the Act, 3,175 applications for licences to extract groundwater for purposes other than domestic and stock use have been lodged with the Commission, and over 5,850 bores from which water is extracted only for domestic and stock use have been registered. The Groundwater Appeal Board will serve to protect the rights of the individual in the equitable distribution and use of groundwater resources.

A Groundwater Conservation Area has been declared in the Koo-Wee-Rup–Dalmore District. Over 200 bores are operated in the district for the irrigation of a total area of about 4,000 hectares of pastures and miscellaneous cash crops, the volume of groundwater extracted annually exceeding the natural rate of replenishment of the aquifer. As a result the groundwater level is falling steadily, leading to a deterioration in water quality in areas adjacent to the coast. Investigations are in progress to determine the safe volume which may be extracted annually.

## STORAGES

### Major non-metropolitan dams

### *Dartmouth*

*Introduction*

The Dartmouth Dam, an earth and rockfill embankment 180 metres high, will be constructed on the Mitta Mitta River in north-eastern Victoria. It will be Australia's highest dam, and will impound a storage of 4,000,000 megalitres, 20 per cent more than Lake Hume, the River Murray Commission's largest storage to date. A 150 megawatt State Electricity Commission power station will also be built at the foot of the dam to provide an annual output of 330 million kilowatt-hours of electric power for Victoria, and a re-regulating pondage will be built downstream of the main dam to contain irregular discharges from the power station so that more constant flows of water can be passed downstream.

Dartmouth Dam is being constructed for the River Murray Commission by the State Rivers and Water Supply Commission of Victoria, which has engaged the Snowy Mountains Engineering Corporation as its design consultant. The River Murray Commission is a statutory body having representative members from the States of Victoria, South Australia, and New South Wales, as well as the Australian Government, and is responsible for regulation of Murray River waters.

The estimated cost of the dam is $84m which will be shared equally between the three States and the Australian Government. Although Dartmouth is located in Victoria, its waters will be controlled by the River Murray Commission and shared between the three States.

The main benefits of Dartmouth will be :

(1) a carry-over storage available in times of drought will supplement Lake Hume and increase supplies to the Murray River system ;

(2) controlled release of Mitta Mitta flows will permit more effective regulation and conservation of the waters of the Upper Murray and its tributaries ;

(3) a substantial amount of electrical energy will be available to meet peak demands particularly in the winter and early spring ;

(4) water of very high quality will be available, ensuring improved control of salinity in the waters of the Murray River ;

(5) some degree of control will be possible over the amount of water flowing from the Mitta Mitta into Lake Hume during times of flood in the Murray valley ;

(6) the dam will assist in the prosperity of the Murray valley and thus in decentralisation ; and

(7) when completed, Dartmouth will provide another recreation and tourist attraction for south-eastern Australia.

The new township of Dartmouth is located about 3 kilometres downstream of the dam site on rising ground overlooking the future pondage. A sealed two-lane road constructed to main-road standards links the town to the Omeo Highway at Mitta Mitta 24 kilometres away. The township is of a modern attractive design and contains offices, workshops, messes, hostels, and other community amenities. During the peak of construction activity at Dartmouth it is expected that about 1,200 people will be living in the township.

*Environmental survey*

To determine the effects of the project on the surrounding environment, the River Murray Commission authorised an environmental survey by a team of botanists, engineers, agriculturists, and forestry and wildlife experts to determine what plant, animal, aquatic, and insect life the area supports, and what effects the construction of the dam will have on the river, adjacent lands, and associated flora and fauna. Participants in the study are the Forests Commission, the Fisheries and Wildlife Division, the Crown Lands and Survey Department, the National Museum, the State Electricity Commission, and the State Rivers and Water Supply Commission. The Conservation Council of Victoria has also participated in the formulation of guidelines for the survey. Field work on the survey, which overall is expected to cost $250,000, has been completed and an assessment of data is now under way. The survey will provide useful information on the environmental effect of a large dam and serve as a guide for similar future studies, which could be reduced in scope if the flora and associated fauna have identifiable relationships with those at Dartmouth.

*Construction*

The agreement to construct Dartmouth Dam was ratified by the four governments concerned on 1 April 1972. Work on the project began soon after, when the State Rivers and Water Supply Commission, using their own plant and plant owned and operated by contractors, commenced building the access road to the township and from the township to the dam. The Commission also built a temporary bridge across the Mitta Mitta River south of the township ; established some of the accommodation facilities in the township ; built the town's water supply storage on Mount Tabor Creek and the town's sewage treatment lagoons ; built an airstrip near Mitta Mitta township ; and prepared the diversion tunnel and access tunnel portals. New houses, hostels, shops,

pavilions, a community hall, and other buildings and facilities were built on a contract basis.

The first major contract for permanent work was let in May 1973. This involved the construction of the diversion tunnel, intake shaft, valve chamber, and access tunnel for the dam. The contract, worth $4.3m, will permit the Mitta Mitta River to be diverted through the tunnel while the dam is being built. The diversion tunnel will ultimately form a low-level outlet with regulating gates located in a chamber below the dam and reached through an access tunnel under the dam. It was completed, and the Mitta Mitta River diverted, early in 1975.

The major contract for the construction of the dam, spillway and outlet work was let in June 1974 at a tender figure of $47m. The work is expected to be completed by November 1977 and will include stripping the site down to bedrock, sealing foundation cracks and fissures by injecting cement grout, constructing cofferdams to protect the work against flood, diverting the river through the diversion tunnel, and preparing the foundation for the main embankment. Construction of the embankment will form the major part of the contract and will involve the placement of about 15.3 million cubic metres of earth and rock. Rock for the outer zones of the dam will be blasted from a quarry developed in the left abutment to form the benched cascade outfall of the spillway, well clear of the dam and the power station. The volume of excavation in open cut for the spillway and cascade will be about 10 million cubic metres.

Current plans are for two outlets, one with a high-level intake and one with a low-level intake, constructed of reinforced concrete. Water for hydro-electric power generation would be released through the high-level outlet and pass through a tunnel under the dam to the power station. These releases would normally be stored in Lake Hume for passage downstream to meet irrigation demands. The low-level outlet, which would discharge through what was previously the diversion tunnel, would be used for irrigation releases. When the water level in the storage fell below the high level intake, it would also be used to maintain streamflow during construction. Completion of the concrete spillway weir and chute will mark the end of the major construction phase. Storage of water is planned to begin about July 1976 when the embankment is expected to have reached a height of 120 metres above the river bed.

Since work began on the project it has created a high level of interest with the general public. The Water Commission has organised a bus service from the township to the dam site each Sunday for tourists and sightseers. A new road to enable visitors to drive to an observation area to view work on the project is under construction. When the dam is completed it will offer great potential for a variety of aquatic sports and recreation.

### *Eildon*

Located on the Goulburn River, immediately below its confluence with the Delatite River, Eildon is Victoria's largest dam. The lake extends over an area of some 13,000 hectares and is the main storage for the Goulburn Irrigation System, the oldest and most developed irrigation system in Australia. The original dam was constructed between 1915 and 1927 and modified during the period 1929 to 1935. Maximum height of this structure was then 47.5 metres and its reservoir capacity was 377,000 megalitres. Between 1952 and 1955 a new embankment 79.25 metres high was constructed immediately downstream of the original dam to impound 3,390,000 megalitres.

### *Hume*

Hume Dam is situated 8 kilometres above the City of Albury, immediately below the confluence of the Mitta Mitta River with the Murray River. The reservoir, known as Lake Hume, covers an area of some 22,500 hectares, and

is the main regulating storage for the Murray River system. Constructed for the River Murray Commission by the Department of Public Works, New South Wales, and the Victorian State Rivers and Water Supply Commission, the dam is a popular tourist attraction for travellers between Melbourne and Sydney. It is close to the site where the famous explorers Hume and Hovell crossed the river in 1824. Water from the dam is used for town and irrigation supplies along the Murray River.

*Waranga*

Waranga Reservoir was first built in 1905 as an off-river storage filled with water diverted from the Goulburn River at Goulburn Weir. It is filled via the Stuart Murray and Cattanach Canals and is one of the largest storages in the system. Waranga Dam has a small catchment area of its own and supplies water to irrigation areas west of the Goulburn including Tatura, Rochester, and Tongala.

*Mokoan*

This large artificial lake with an area of 79 square kilometres was formed by an earthen dam 10 metres high and 7.5 kilometres long. It was built in 1970 across the end of the Winton Swamp near Benalla in north-eastern Victoria. In conjunction with the Nillahcootie Reservoir, this off-river storage harnesses the flows of the Broken River and its tributaries. Special facilities were provided to maintain breeding areas for bird life. Storage capacity is 364,800 megalitres.

*Rocklands*

Located on the Glenelg River, 14.5 kilometres upstream from Balmoral, it is the major storage of the unique Wimmera–Mallee domestic and stock supply system in north-western Victoria. This was the first example in Victoria where a south flowing stream was diverted northwards via a tunnel. Storage capacity is 335,500 megalitres.

*Eppalock*

Situated on the Campaspe River above Axedale near Bendigo in north-western Victoria, Eppalock Dam was built between 1960 and 1962. Waters of the reservoir are released downstream to irrigate farms along the river and within the Campaspe Irrigation District south of Rochester. At periods of peak demand in the Goulburn Irrigation System, supplementary supplies are pumped from the river to the Waranga Western Channel. Eppalock water is also conveyed by pumping to Bendigo in a 26 kilometre pipeline. The lake is well known as a popular recreation spot, especially for speedboat enthusiasts.

*Glenmaggie*

The keystone of the Gippsland irrigation areas, Glenmaggie Dam, is situated on the Macalister River in Gippsland, eastern Victoria. The reservoir supplies irrigated properties in the vicinity of the towns of Maffra, Heyfield, Stratford, and the City of Sale. Soldier settlement after the Second World War necessitated an increase in irrigation areas and the storage was enlarged from 61,700 megalitres to 190,300 megalitres.

*Bellfield*

Built as a reserve storage for the Wimmera–Mallee Domestic and Stock System in north-western Victoria, Bellfield Dam was constructed between 1963 and 1967 on Fyans Creek upstream of Halls Gap in the Grampians region. The dam is normally kept full and is depleted only at the end of a dry period in the Wimmera–Mallee area. Water from the dam is used primarily for stock and domestic purposes in the system.

*Devilbend*

Constructed to supply the rapidly growing urban and industrial demands of the Mornington Peninsula, this earth and rockfill dam, 27.4 metres high, was completed in 1964. The project includes a pumping station below the dam and catch drains around the reservoir periphery to prevent pollution. Storage capacity is 14,560 megalitres.

*Tarago*

The Tarago earth and rockfill dam, 34.1 metres high, on the Tarago River was constructed in 1968 to provide a new storage for the Mornington Peninsula system to supplement the hitherto adequate aqueduct diversions. The design provided for a 50 per cent enlargement of the storage capacity, which was completed in 1972.

*Rosslynne*

The State Rivers and Water Supply Commission's most recent large dam is Rosslyne Reservoir on Jacksons Creek near Gisborne. It was built to provide additional water supplies to the rapidly expanding townships of Sunbury and Gisborne, and to support irrigation development by diverters along the Maribyrnong River. The dam will have a storage capacity of 24,700 megalitres.

*Buffalo—Stage 1*

Set at the foot of the western flank of Mt Buffalo and its national park, this dam was constructed in 1965. The storage impounded by this earth and rockfill dam, 30.5 metres high, forms the first stage of the Buffalo River project and safeguards pumped supplies to high value crop production and the City of Wangaratta in north-eastern Victoria.

*Pykes Creek*

Some 72 kilometres west of Melbourne, Pykes Creek dam impounds a storage for irrigation and domestic requirements in the Bacchus Marsh and Werribee areas. The Western Highway crosses the site by an embankment constructed below the dam. An earthern dam 39 metres high, it was first built in 1911 and raised in 1930.

*Merrimu*

Merrimu Dam was constructed on the Coimadai Creek north-east of Bacchus Marsh as the first stage of an irrigation and town supply project. The existing first stage storage impounds water diverted by means of a tunnel from Goodmans Creek, provides a reserve for the Bacchus Marsh and Werribee Irrigation Districts, and will supplement urban supply for the Melbourne metropolitan satellite development at Melton. The second stage of the project provides for the diversion of the Lerderderg River by another tunnel to connect the river to Goodmans Creek. In the third stage, it is proposed to raise the dam embankment. Storage capacity now is 19,120 megalitres.

*William Hovell*

Lake William Hovell is located on the King River, 24 kilometres above Whitfield in northern Victoria. It takes its name from the Australian explorer William Hovell who passed through the region in 1824 with Hamilton Hume. The dam consists of an earth and rockfill embankment and a concrete lined chute and ski-jump spillway. Water from the dam is used for irrigating tobacco, hops, and grazing areas lower down the King River and in the Ovens River Valley. Storage capacity is 12,330 megalitres.

## VICTORIA—LANDS UNDER IRRIGATION : EXTENT OF IRRIGATION AND AREAS WATERED, 1973–74

| Name of irrigation district area, etc. | Total area of holdings in irrigation districts | Area classified as irrigable within constituted districts | Water rights apportioned including extra water right | Area irrigated, including lands adjoining a district | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cereals | Lucerne grown for pasture and hay | Sorghum and other annual fodder crops | Pastures | | | Vineyards | Orchards | Market gardens | Fallow and mis-cellaneous | Total |
| | | | | | | | Native | Annual | Perennial | | | | | |
| | hectares | hectares | megalitres | hectares | hectares | hectares | hectares | hectares | hectares | hectares | hectares | hectares | hectares | hectares |
| Goulburn–Campaspe–Loddon System— | | | | | | | | | | | | | | |
| Shepparton | 90,581.8 | 64,964.6 | 190,224 | 14.0 | 751.0 | 648.0 | 43.0 | 12,528.0 | 17,484.0 | 132.0 | 4,834.0 | 325.0 | 289.0 | 37,048.0 |
| Rodney | 109,303.0 | 88,040.4 | 254,195 | 168.2 | 1,567.8 | 333.2 | 975.5 | 19,198.0 | 28,805.2 | 61.3 | 3,698.4 | 832.6 | 514.9 | 56,155.1 |
| Tongala–Stanhope | 30,948.0 | 27,281.2 | 104,660 | 106.0 | 120.0 | 25.0 | 4.0 | 6,538.0 | 16,453.0 | .. | 256.0 | 56.0 | 22.0 | 23,580.0 |
| Deakin | 63,813.0 | 17,886.2 | 42,630 | 112.0 | 295.0 | 107.0 | 390.0 | 6,289.0 | 5,853.0 | .. | 12.0 | 120.0 | 44.0 | 13,222.0 |
| Rochester | 75,932.5 | 59,031.9 | 147,708 | 349.0 | 494.0 | 677.0 | 93.0 | 13,468.0 | 20,616.0 | .. | 50.0 | 148.0 | 320.0 | 36,215.0 |
| Dingee | 4,192.9 | 3,151.9 | 9,965 | .. | 7.0 | .. | 8.0 | 1,042.0 | 1,202.0 | .. | .. | .. | 5.0 | 2,264.0 |
| Calivil | 25,970.3 | 20,329.3 | 39,042 | .. | 543.0 | 200.0 | 32.0 | 4,869.0 | 3,870.0 | .. | .. | .. | 246.0 | 9,760.0 |
| Tragowel Plains | 88,682.5 | 70,119.0 | 121,020 | 6.0 | 369.0 | 863.0 | 2,918.0 | 25,060.0 | 6,829.0 | .. | .. | .. | 1,101.0 | 37,146.0 |
| Boort | 45,403.6 | 30,418.4 | 50,898 | 127.0 | 1,279.0 | 894.0 | 29.0 | 8,193.0 | 2,506.0 | .. | .. | 34.0 | 1,661.0 | 14,723.0 |
| Campaspe | 8,695.3 | 4,925.4 | 14,741 | .. | 434.0 | 35.0 | 15.0 | 700.0 | 1,366.0 | .. | .. | 249.0 | .. | 2,799.0 |
| East Loddon | .. | .. | .. | .. | 24.0 | .. | .. | 75.0 | 14.0 | .. | .. | .. | 16.0 | 129.0 |
| West Loddon | .. | .. | .. | .. | 170.0 | 40.0 | .. | 493.0 | 63.0 | .. | .. | .. | 263.0 | 1,029.0 |
| Total | 543,522.9 | 386,148.3 | 975,083 | 882.2 | 6,053.8 | 3,822.2 | 4,507.5 | 98,453.0 | 105,061.2 | 193.3 | 8,850.4 | 1,764.6 | 4,481.9 | 234,070.1 |
| Murray River System (Torrumbarry Weir)— | | | | | | | | | | | | | | |
| Cohuna | 45,815.0 | 29,017.4 | 120,236 | 204.0 | 804.0 | 381.0 | 1,872.0 | 14,473.0 | 26,843.0 | .. | 6.0 | 5.0 | 219.0 | 44,807.0 |
| Koondrook | 37,843.8 | 28,185.7 | 71,197 | 164.0 | 319.0 | 373.0 | 2,324.0 | 15,355.0 | 4,631.0 | 2.0 | 186.0 | 3.0 | 543.0 | 23,900.0 |
| Swan Hill | 15,603.2 | 9,910.4 | 55,759 | 53.0 | 507.0 | 17.0 | 71.0 | 1,493.0 | 6,414.0 | 1,189.0 | 439.0 | 220.0 | 23.0 | 10,426.0 |
| Third Lake | 7,915.4 | 3,728.3 | 11,812 | 10.0 | 94.0 | .. | .. | 1,769.0 | 155.0 | .. | .. | .. | .. | 2,028.0 |
| Mystic Park | 8,399.1 | 4,335.2 | 11,535 | .. | 105.0 | 11.0 | 114.0 | 1,527.0 | 221.0 | 23.0 | 2.0 | 1.0 | .. | 2,004.0 |
| Tresco | 1,857.3 | 773.9 | 5,015 | .. | 55.0 | 1.0 | .. | 11.0 | 13.0 | 595.0 | 89.0 | 45.0 | .. | 809.0 |
| Fish Point | 7,431.4 | 5,314.5 | 9,857 | 12.0 | 16.0 | 87.0 | 482.0 | 1,223.0 | 265.0 | .. | .. | 2.0 | 41.0 | 2,128.0 |
| Kerang | 37,175.1 | 29,724.1 | 68,816 | 35.0 | 132.0 | 64.0 | 212.0 | 11,668.0 | 4,495.0 | .. | .. | .. | 811.0 | 17,417.0 |
| Kerang North-West | .. | .. | .. | 81.0 | 196.0 | 83.0 | 50.0 | 574.0 | 32.0 | 45.0 | 79.0 | 5.0 | 18.0 | 1,163.0 |
| Total | 162,040.3 | 110.989.5 | 354,227 | 559.0 | 2,228.0 | 1,017.0 | 5,125.0 | 48,093.0 | 43,069.0 | 1,854.0 | 801.0 | 281.0 | 1,655.0 | 104,682.0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yarrawonga weir Murray valley | 121,951.5 | 88,611.2 | 246,101 | 561.8 | 1,428.1 | 1,401.4 | 1,755.4 | 20,584.3 | 18,941.4 | 233.8 | 2,396.0 | 242.8 | 1,039.1 | 48,584.1 |
| Direct from river by pumping— | | | | | | | | | | | | | | |
| Nyah | 1,564.5 | 1,070.2 | 9,070 | 202.3 | 667.4 | 106.3 | 7.3 | 1,169.3 | 523.6 | 194.4 | 216.4 | 114.8 | 293.4 | 3,495.2 |
| Red Cliffs | 5,510.5 | 4,618.9 | 43,693 | .. | 199.7 | 18.8 | 52.3 | 19.1 | 223.3 | 5,449.9 | 1,355.3 | 635.0 | 46.0 | 7,999.4 |
| Merbein | 3,733.5 | 3,145.5 | 30,140 | 32.0 | 109.5 | 34.0 | 26.0 | 1,027.9 | 3,738.9 | 757.4 | 88.1 | .. | 16.7 | 5,830.5 |
| Robinvale | 3,609.1 | 2,281.0 | 17,533 | .. | 35.0 | .. | .. | 42.0 | 589.0 | 2,808.0 | 945.0 | 544.0 | .. | 4,963.0 |
| Total | 14,417.6 | 11,115.6 | 100,436 | 234.3 | 1,011.6 | 159.1 | 85.6 | 2,258.3 | 5,074.8 | 9,209.7 | 2,604.8 | 1,293.8 | 356.1 | 22,288.1 |
| First Mildura Trust | 15,863.7 | 7,933.3 | 72,542 | .. | .. | .. | .. | .. | 269.1 | 6,160.9 | 310.8 | .. | 1,192.5 | 7,933.3 |
| Murray River System Total | 314,273.1 | 218,649.6 | 773,306 | 1,355.1 | 4,667.7 | 2,577.5 | 6,966.0 | 70,935.6 | 67,354.3 | 17,458.4 | 6,112.6 | 1,817.6 | 4,242.7 | 183,487.5 |
| Other northern systems— | | | | | | | | | | | | | | |
| Coliban | .. | .. | .. | 4.0 | 155.0 | .. | 168.0 | 758.0 | 2,309.0 | 4.0 | 614.0 | 96.0 | 19.0 | 4,127.0 |
| Western Wimmera | .. | 2,582.0 | .. | .. | 48.8 | 56.7 | .. | .. | 2,531.0 | 0.2 | 62.8 | 5.0 | .. | 2,704.5 |
| Wimmera United | .. | 466.0 | .. | .. | 63.3 | 11.0 | .. | 15.3 | 385.6 | .. | 5.3 | 4.0 | .. | 484.5 |
| Total | .. | 3,048.0 | .. | 4.0 | 267.1 | 67.7 | 168.0 | 773.3 | 5,225.6 | 4.2 | 682.1 | 105.0 | 19.0 | 7,316.0 |
| Southern systems— | | | | | | | | | | | | | | |
| Bacchus Marsh | 2,545.6 | 1,285.5 | 3,956 | 7.0 | 107.0 | .. | 23.0 | .. | 869.0 | .. | 181.0 | 177.0 | 15.0 | 1,379.0 |
| Werribee | 3,872.9 | 3,245.6 | 9,902 | .. | 115.0 | 5.0 | .. | 15.0 | 1,556.0 | .. | 57.0 | 1,532.0 | 13.0 | 3,293.0 |
| Maffra-Sale | 34,900.2 | 21,389.0 | 63,551 | 34.0 | 76.0 | 139.0 | 284.0 | .. | 18,595.0 | .. | .. | 27.0 | .. | 19,155.0 |
| Central Gippsland | 17,898.7 | 13,960.8 | 38,643 | .. | 27.0 | 23.0 | .. | .. | 10,883.0 | .. | .. | .. | .. | 10,933.0 |
| Mornington Peninsula | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 64.8 | 45.0 | 109.8 |
| Bellarine Peninsula | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 98.0 | 20.0 | 118.0 |
| Total | 59,217.4 | 39,880.9 | 116,052 | 41.0 | 325.0 | 167.0 | 307.0 | 15.0 | 31,903.0 | .. | 238.0 | 1,898.8 | 93.0 | 34,987.8 |
| Private diversions throughout the State | .. | .. | .. | 374.0 | 6,115.0 | 3,829.0 | 1,556.0 | 7,277.0 | 48,933.0 | 2,465.0 | 2,718.0 | 7,322.0 | 4,587.0 | 85,176.0 |
| GRAND TOTAL 1973–74 | 917,013.4 | 647,726.8 | 1,864,441 | 2,656.3 | 17,428.6 | 10,463.4 | 13,504.5 | 177,453.9 | 258,477.1 | 20,120.9 | 18,601.1 | 12,908.0 | 13,423.6 | 545,037.4 |
| GRAND TOTAL 1972–73 | 914,019.0 | 643,962.0 | 1,794,677 | 17,117.0 | 22,157.0 | 10,294.0 | 17,808.0 | 218,061.0 | 246,420.0 | 20,850.0 | 18,889.0 | 12,791.0 | 14,607.0 | 598,994.0 |

## IRRIGATION

Most irrigation is carried out in districts directly controlled by the Commission, although there is an increasingly large proportion of "private diverters", irrigators who are authorised to take water from streams, lakes, etc., but who do not come within the boundaries of an irrigation district. A feature of the districts is the system of "water rights" under which a certain quantity of water is assigned to each district and allotted to the lands commanded and suitable for irrigation. The irrigators pay a fixed sum for this water each year, whether they use it or not, and also pay a general rate. Water rights are available in all except the very driest years and water in excess of the water right can be bought in most seasons. The water right system assures irrigators of a definite quantity of water each year, and the Commission can rely on fairly constant revenue to meet the cost of district operation. Water usage varies according to seasonal conditions and the water right system provides a constant minimum income to the Commission.

A feature of Victorian irrigation policy has been the development of closer settlement by intensive irrigation, that is, by allocating relatively large quantities of water per holding instead of limiting the allocation of water to a portion of each holding. This has meant that Victorian irrigation is predominantly devoted to dairying and horticulture, rather than to sheep raising. The advantage of intensive irrigation is that much higher returns are available from a given quantity of water and, consequently, a much greater rural population is supported. In 1973–74 the total area under development in irrigation districts was 647,706 hectares and the total water right delivered to these lands was 1,842,176 megalitres.

Private irrigation by diversion of water from rivers, lakes, etc., has increased in recent years. From 1942–43 to 1974–75 the annual area watered privately increased from 9,454 hectares to 84,471 hectares, the latter being 12.5 per cent of the total area irrigated. The number of private diversions authorised during 1974–75 was 10,770 and the water delivered was used mainly to produce annual and perennial pastures and fodder, as well as potatoes, tobacco, hops, vegetables, vines, fruit, and cereals. About half the area privately watered is supplied from streams regulated by storages, the other half being from streams wholly dependent on rainfall. Many private storage dams are being built, frequently at substantial cost, to insure against low flows in the streams normally used.

## COUNTRY TOWN SUPPLIES

### General

During the gold rushes of the 1850s large numbers of people migrated to areas without adequate water supply either for domestic or for mining purposes. The mining population was too unsettled to accept responsibility, and no suitable supply authority existed. The Government, therefore, constructed reservoirs where needs were most pressing. The earliest reticulated supplies were to Bendigo in 1859, Ballarat in 1862, and Geelong in 1865. As early as 1872 a number of municipal corporations received government loans with which many waterworks of permanent value were constructed.

The first comprehensive legislation for the supply of water to country districts was the Water Conservation Act of 1881. This provided for constitution of Waterworks Trusts to construct and manage supply works throughout Victoria. More detailed legislation to control supplies in urban areas was added in 1884. The end of the Second World War saw 258 country towns in Victoria with water supply systems, providing reticulated supplies to 51 per cent of the State's population outside the metropolis. Country urban communities with reticulated water supplies now number 446, of which 33 have water treatment facilities.

These systems provide reticulated supplies to 85 per cent of the 1.2 million Victorians living outside the metropolitan area. The populations of individual towns range from 120,000 (Geelong) to about 50. Supplies to 148 of these towns (312,000 population) are managed directly by the State Rivers and Water Supply Commission—either as part of its major urban supply systems, or as isolated towns in areas supplied for irrigation or for rural domestic and stock purposes. The remaining 298 town supplies (702,000 population) are managed by local water authorities specially constituted for the purpose under the Water Act.

The total capital expenditure on country town water supplies now amounts to some $168m. Of this amount 90 per cent or $151m has been spent since 1945. More than 55 per cent of the annual capital charges on this expenditure is borne by the Victorian Government by way of capital grants, interest subsidies on loans, and (in the case of very small townships supplied by local authorities) by deferring temporarily part of the capital liability which would normally be borne locally. During the 1973–74 year alone, capital expenditure on town water supplies by the Commission itself was $1.9m, and that by local authorities was $7m. Expenditure by sewerage authorities was $14.3m. The total expenditure on these urban services was, therefore, $23.2m, as compared with $15.3m for all other Commission works.

The 148 town supplies managed directly by the Commission fall into two categories—those forming part of the large main urban supply systems, and those located within irrigation or waterworks districts and operated as part of those systems. The main urban supplies comprise towns in the Mornington Peninsula, the Bellarine Peninsula, the Otway System, and the Coliban System. All these were constructed principally for the supply of towns only, although the Coliban System also provides substantial irrigation supplies to the Bendigo–Castlemaine area. The general responsibilities of the Commission in the supply of water to country towns are essentially similar to those noted below for the local authorities.

## Local authorities

The establishment of separate authorities to provide water and sewerage services to country towns is unique to Victoria. These authorities are independent responsible statutory bodies which make their own decisions, engage their own staff, and construct and manage their own works. However, as the Victorian Government usually provides a substantial degree of financial assistance, all their operations and proposals are subject to general review by the Commission. At June 1974 there were 204 local water authorities throughout Victoria supplying 294 country towns. Four of these authorities operate under special Acts. The remainder have been constituted under the Water Act, which provides several different ways in which such a local authority could be constituted so as to meet a variety of local conditions.

### *Organisation*

There are two broad classes of local water authority:

(1) "Local governing bodies", which are municipal councils constituted as local governing bodies under the Water Act; and

(2) "waterworks", the commissioners of which might comprise:

(i) councillors for the time being of the municipality concerned plus one Government nominee;

(ii) councillors of one or more municipal ridings plus up to three nominees; or

(iii) commissioners elected directly by the water ratepayers.

Local governing bodies (25) are usually limited to cities or boroughs as their water supply districts must be essentially urban in character. Although a local governing body may be composed entirely of councillors and use the Council's

name, it is a separate legal entity and its business and accounts must be kept quite apart from the administration of municipal affairs. Waterworks trusts usually comprise about six commissioners, and have jurisdiction over a waterworks district, within which there may be one or more urban districts.

Several local water authorities operate under special Acts which are usually supplementary to the Water Act. These special authorities include the Mildura Urban Waterworks Trust, the Geelong Waterworks and Sewerage Trust, the Latrobe Valley Water and Sewerage Board supplying water in bulk to towns and industries in the Latrobe valley, and the West Moorabool Water Board which supplies water in bulk to the local authorities at Ballarat and Geelong. A number of small townships in Victoria are still supplied by local municipal councils under powers conferred by the Local Government Act. However, the provisions of that Act in relation to water supply are insufficiently specific for the management of any substantial town water supply system. Although such supplies can receive consideration for a capital grant under the town water supplies assistance formula, the remainder of the costs must be found by the municipality concerned from its normal sources of loan funds.

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