CHAPTER XXVI.
WATER CONSERVATION AND IRRIGATION.
A. RESOURCES, UTILIZATION AND NATIONAL AND INTERSTATE ASPECTS.
§ 1. Introduction.

1. **Special Article.**—Official Year Book, No. 37, pp. 1096–1141, contained a special article " The Conservation and Use of Water in Australia " prepared by Mr. Ulrich Ellis of Canberra. This article, which incorporated basic information supplied by the various Commonwealth and State Departments and other bodies connected with water conservation, presented a comprehensive picture of recent development in this field. The previous issue of the Year Book which contained such a survey was No. 23, 1930, pp. 636–661.

In subsequent issues much of Mr. Ellis's article of a statistical nature, including that contained in this chapter in recent years, has been advanced, as has the general information on the more important developments in this field, but for details of general, descriptive and historical matter reference should be made to the original article.

2. **Geographical and Climatic Factors.**—The opening section of the special article contained a simplified picture of the main geographical and climatic features of Australia, presented in order to enable the reader to appreciate the significance of the Australian water pattern. This is not reproduced, but Chapter II.—Physiography, of this issue, contains considerable detail of the climatic features of Australia with some reference to geographical features, while earlier issues of the Year Book deal exhaustively with these subjects.

3. **Statistical Aspects.**—It should be noted that the basis of recording statistics of water use differs in several States. Therefore, while every attempt has been made to present a uniform statistical picture, it has been difficult to ensure that statistics quoted as between States are strictly comparable in detail. Some steps have been taken by State authorities with a view to securing uniformity of statistical data, but until this objective has been achieved allowance should be made for this factor in this Chapter.

The Chapter deals with the conservation and utilization of water on a nation-wide or State-wide basis, and also devotes particular attention to these activities in relation to rural areas and purposes. For information on water conservation and utilization for the purpose of water supply and sewerage in the metropolitan areas, cities and towns of Australia *see* Chapter XV.—Local Government, § 5. Water Supply, Sewerage and Drainage. For additional information on hydro-electric power generation and on the various existing and projected schemes *see* Chapter XXV.—Electric Power Generation and Distribution.

4. **Select Bibliography.**—Appended to the special article in Official Year Book No. 37 is a select bibliography containing a list of selected books, reports, papers, etc. dealing with the development of the water resources of Australia and their conservation (*see* pp. 1140–1). The works included, numbering more than thirty, are classified under the headings " General ", " Murray River ", " Sub-surface Water ", " Snowy River ", " Hydro-electricity ", " States " and " Catchments ".

§ 2. Water Resources and their Utilization.

1. **Surface Supplies.**—Though river gaugings have been recorded over considerable periods in some parts of Australia, records elsewhere are intermittent, of short duration, or non-existent. Therefore, it is impossible at present to estimate, with any degree of reliability, the total average annual flow of Australian streams and it has been doubted whether the total annual average flow of all Australian Rivers would exceed 60,000,000 acre feet, a figure small in comparison with the flow of rivers in other continents, some examples of which are given below expressed as mean annual discharges in millions of acre feet: Nile, 72; Danube, 228; Amazon, 1,780; Volga, 148; Mississippi, 474; and the ten main rivers of the United States of America, 900 (in the aggregate).

2. **Major Dams and Reservoirs.**—The table below lists existing major dams and reservoirs, together with those under construction or projected, as at the middle of 1951.

MAJOR DAMS AND RESERVOIRS IN AUSTRALIA.

Name.	Location.	Capacity (Acre feet).	Height of Wall (Feet).	Remarks.
EXISTING DAMS AND RESERVOIRS.				
Hume	Murray River near Albury	1,250,000	106	Part of Murray River Scheme—storage for domestic, stock and irrigation purposes. To be increased to 2,000,000 acre feet.
Miena	Great Lake, Tasmania	1,125,000	40	Regulates water to Waddamana hydro-electric power station.
Burrinjuck ..	Murrumbidgee River, New South Wales	771,640	247	Storage for irrigation and production of hydro-electric power.
Lake Victoria ..	Murray River near South Australian border, in New South Wales	551,700	..	Natural storage for irrigation in South Australia.
Waranga	Goulburn River, Victoria	333,400	..	Earthen embankment, 23,800 feet long. Irrigation storage.
Eildon	Upper Goulburn River, Victoria	306,000	..	Rock filled embankment, 2,300 feet long and concrete spillway, 700 feet. Irrigation storage.
Wyangala ..	Lachlan River, New South Wales	303,900	190	Storage for domestic, stock and irrigation purposes and for generation of hydro-electric power.
Clark	Derwent River, Tasmania	243,000	200	Serves Tarraleah hydro-electric power station.
Avon	Nepean River, New South Wales	173,800	230	Part of Sydney water supply.
Glenmaggie ..	Gippsland, Victoria	106,000	100	Storage for irrigation.
DAMS AND RESERVOIRS UNDER CONSTRUCTION OR PROJECTED.				
Adaminaby ..	Eucumbene River, New South Wales	3,500,000	330	Projected as part of Snowy Mountains Hydro-electric Scheme.
Eildon	Upper Goulburn River, Victoria	2,750,000	..	Existing dam being enlarged for irrigation storage and production of hydro-electric power.
Menindee Lakes Project	Darling River near Menindee, New South Wales	2,000,000	..	Part of Darling River water conservation scheme—under construction.
Warragamba ..	Warragamba River, New South Wales	1,678,500	415	Under construction for Sydney water supply.
Jindabyne ..	Snowy River, New South Wales	1,200,000	260	Projected as part of Snowy Mountains Hydro-electric Scheme.
Upper Murray ..	Upper Murray River, New South Wales	Not less than 1,000,000	..	,, ,, ,, ,,
Blowering ..	Tumut River, New South Wales	846,000	300	Projected as part of Snowy diversion scheme.
Somerset	Stanley River, Queensland	724,000	130	Under construction for Brisbane-Ipswich water supply.
Burrendong ..	Macquarie River, near Wellington, New South Wales	650,000	193	Under construction for rural water supplies.
Warkworth ..	Wollombi Brook (Hunter Valley), New South Wales	400,000	100	Projected as a flood mitigation dam for the Hunter Valley.
Keepit	Namoi River, near Gunnedah, New South Wales	345,000	135	Under construction for rural water supplies.
Tantangara ..	Murrumbidgee River, New South Wales	300,000	150	Projected as part of Snowy Mountains Hydro-electric Scheme.
Glenbawn ..	Hunter River, near Scone, New South Wales	296,000	240	Under construction as part of Hunter Valley conservation work.
Upper Yarra ..	Yarra River, Victoria	110,000	270	Under construction for Melbourne water supply.
Lake Brewster ..	Lachlan River, near Hillston, New South Wales	108,000	..	Storage of rural water supplies for the Lower Lachlan —works almost complete.

3. **Irrigation.**—(i) *History.* For some brief remarks on the history of irrigation in Australia referring to the efforts of the Chaffey Brothers and to the Victorian Irrigation Act in 1886 *see* previous issues.

(ii) *Extent and Nature of Irrigated Culture.* About half of Australia's irrigated acreage is now in Victoria, and about two-thirds is situated along the Murray and its tributaries (including the Murrumbidgee) in the three States of New South Wales, Victoria and South Australia. In these areas served by the Murray and its tributaries irrigation water is used extensively for vines, orchards, pastures, fodders, and for domestic and stock purposes. Approximately half of Queensland's irrigated acreage is devoted to sugar cane. Western Australia's small irrigated acreage is confined to areas in the south-west where fodders and pastures are served. Irrigation schemes have not been developed in Tasmania or the Northern Territory.

The following table shows the area of land irrigated in each State during the years 1938–39 to 1941–42 and 1945–46 to 1950–51 :—

AREA OF LAND UNDER IRRIGATED CULTURE.

(Acres.)

Season.	N.S.W. (*a*)	Victoria.	Q'land.	S. Aust.	W. Aust.	Tas.	A.C.T.	Australia.
1938–39 ..	*b*183,518	515,357	48,953	43,602	14,278	8,599	50	814,357
1939–40 ..	326,875	517,903	55,153	44,470	15,443	8,656	263	968,763
1940–41 ..	325,075	596,662	60,961	46,268	14,513	8,821	391	1,052,691
1941–42(*c*) ..	354,762	602,074	(*d*)	45,757	15,060	6,975	48	(*d*)
1945–46 ..	331,030	656,845	68,347	42,192	16,864	11,279	502	1,127,059
1946–47 ..	544,775	708,590	79,030	46,145	17,947	9,326	743	1,406,556
1947–48 ..	510,168	686,848	84,052	42,583	19,197	9,908	574	1,353,330
1948–49 ..	576,723	722,968	91,417	48,185	25,381	9,563	539	1,474,776
1949–50 ..	628,610	662,290	90,543	49,089	31,573	7,525	637	1,470,267
1950–51 ..	597,773	716,051	83,150	79,062	28,197	7,242	468	1,511,943

(*a*) Includes pasture and fallow lands. Source: Water Conservation and Irrigation Commission.
(*b*) Excludes pasture and fallow lands. (*c*) Details for years 1942–43 to 1944–45 are not available.
(*d*) Not available.

The next table shows the area of land irrigated in each State during 1950–51 according to the nature of irrigated culture.

AREA OF LAND UNDER IRRIGATED CULTURE, 1950–51.

(Acres.)

Crop.	N.S.W.(*a*)	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	A.C.T.	Aust.
Cereals for Grain	51,527	25,264	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	76,791
Rice	37,223	..	(*b*)	..	..	..	..	37,223
Vegetables ..	15,454	15,911	17,473	7,841	6,777	(*b*)	145	63,601
Orchards ..	17,485	35,205	2,278	13,054	3,872	981	..	156,000
Vineyards ..	11,692	42,582		28,506	345	..	..	
Sugar-cane ..	..	..	45,108	..	..	..	..	45,108
Hops	..	..	..	..	..	1,075	..	1,075
Cotton	..	..	219	..	..	..	..	219
Other Crops (including Fodder and Fallow land)	81,687	48,209	(*c*)14,949	4,230	877	486	301	150,739
Total Crops	215,068	167,171	80,027	53,631	11,871	2,542	446	530,756
Pastures ..	382,705	*d* 548,880	3,123	25,431	16,326	4,700	22	981,187
Total ..	597,773	716,051	83,150	79,062	28,197	7,242	468	1,511,943

(*a*) Source: Water Conservation and Irrigation Commission. (*b*) Included in Other Crops.
(*c*) Includes tobacco, 2,969 acres. (*d*) Includes lucerne for pasture, 26,692 acres.

(iii) *Irrigation Trends.* In Official Year Book, No. 37, p. 1099, the following trends in irrigation practice were described, viz. :—the improvement of irrigation techniques in established areas, a growing appreciation of the benefits and necessity of irrigation in humid and sub-humid areas with a flush annual rainfall, the use of irrigation to stabilize the stock industries, especially on an " extensive " basis, consideration regarding the provision of weirs to prevent the entry of salt water, the increasing quest for cheap electric power to aid pumping operations for stock, domestic and irrigation purposes, and an increase in the extent of spray irrigation.

(iv) *Research.* Comprehensive programmes of research and investigation are being pursued by State water and agricultural authorities and the Commonwealth Scientific and Industrial Research Organization, often in collaboration. Special attention is being given to the following :—high water tables due to the application of water to land where no natural drainage lines exist, or where drainage lines are too small to cope with extra water ; presence of salt in semi-arid soils, resulting in surface accumulation ; salinity of water, which makes it unsuitable for human beings, stock and plant life ; adverse reactions of semi-arid soil types to increasing quantities of water which affect the sub-soil ; increasing density of stock on irrigated pastures which leads to the spread of such diseases as foot rot and fluke in sheep, and mastitis and contagious abortion in cattle ; and growth problems affecting plants and trees.

The Commonwealth Scientific and Industrial Research Organization maintains the following research stations :—Merbein (Victoria)—horticultural problems, particularly of the dried vine fruits industry ; Griffith (New South Wales)—influence of irrigation on plant life (using horticultural trees and vegetables as test plants), land drainage and soil structure ; Deniliquin (New South Wales)—pastures ; Werribee (Victoria)—diseases of dairy cattle. These stations are in close contact with the settlers. In the maintenance of Merbein and Griffith Stations the Commonwealth is assisted, financially and otherwise, by the New South Wales Water Conservation and Irrigation Commission, by the Dried Fruits Export Control Board and by private organizations.

The Soils Division of the Organization has made detailed surveys of more than a million acres since 1927, with less detailed reconnaissance surveys over many millions of acres. The Division works closely with State authorities. The keynote of soil investigations is relationship between soil and land use, and there is an increasing tendency to seek such surveys before irrigation districts are established.

The Irrigation Research and Extension Committee plays an important part in the agricultural activity of the Murrumbidgee Irrigation areas. It is representative of the State Department of Agriculture, the Commonwealth Scientific and Industrial Research Organization, the Rural Bank of New South Wales, the Soil Conservation Service of New South Wales and certain farmers' organizations (including Extension Groups). Finance is provided by these authorities on an agreed basis. The objectives are :— to enable the agricultural extension services to the farmers in the defined sub-region to be continued and developed ; to provide a system for advising on local agricultural policy and organization ; to provide means for farmer opinion to have due weight in the consideration of regional agricultural administration and policy ; to achieve a unified approach to sub-regional extension in all branches of agriculture ; to advise on the research needs of the sub-region and the co-ordination of the agricultural research of the various rural institutions working therein ; to achieve close liaison between research and extension ; and to conduct research in extension methods.

4. **Preservation of Catchments.**—As water conservation commences on the catchments it is becoming increasingly recognized that anything which interferes with catchment efficiency affects the quantity of water available for all purposes. Active steps are being taken to counteract soil erosion, to conserve soil generally, and to minimize effects of floods, overstocking, bush fires, and destruction of vegetative cover. All States and the Commonwealth have initiated forestry policies which provide for reafforestation and the preservation of catchments. In recent years efforts to counteract soil erosion have been intensified and there is some evidence of a more unified approach to catchment, water, forestry, and land use factors regarded as parts of a single problem.

5. **Hydro-electric Power.**—Hydro-electricity is generated in all States except South Australia and Western Australia and the Northern Territory. Water is the sole source of electric power in Tasmania, all other States depending largely on steam and oil. On the mainland it is usual to allot water for irrigation purposes, combining this with hydro-electricity to whatever extent is possible. During summer, when irrigation is proceeding, there is ample discharge for power, but in the non-watering period the main objective is to store water. Information on existing and projected hydro-electric schemes is given in later sections of this Chapter, and the subject of the generation of electric power from water resources is discussed in this issue in Chapter XXV.—Electric Power Generation and Distribution, which contains, in addition, further particulars of the various schemes.

6. **Sub-surface Supplies.**—(i) *General.* While a more or less complete general picture of the available and potential surface water resources exists, much remains to be done with regard to the location and development of sub-surface supplies (artesian, sub-artesian and ground water), in view of their importance as the basis of settlement over large areas of Australia.

The extent and potentials of the artesian basins—particularly the Great Artesian Basin—have been fairly accurately determined, and the use of sub-artesian supplies is extensive and more development is possible. The shallower groundwater supplies, however, particularly along alluvium valleys and coastal sandbed areas, have not been investigated and developed in any degree, except in a few localities.

(ii) *Artesian and Sub-artesian Supplies.* Pressure water, variable in quantity and quality, either artesian or sub-artesian, is obtainable in many parts of Australia, the various artesian basins extending over approximately one-third of the continent.

The Great Artesian Basin, the most extensive in the world, underlies an area of approximately 550,000 square miles, comprising about 350,000 in Queensland, 76,000 in New South Wales, 100,000 in South Australia and 24,000 in the Northern Territory. Of the numerous defined major and minor water-bearing basins in Australia, the following are the principal :—

PRINCIPAL WATER-BEARING BASINS : AUSTRALIA.

Name.	State.	Geological Age.	Area.	Depth of Water.
			Square Miles.	Feet.
Great Artesian..	Queensland, New South Wales, South Australia and Northern Territory	Cretaceous-Jurassic..	550,000	Up to 7,000
Murray ..	Victoria, New South Wales, and South Australia	Miocene	107,000	100 to 900
Torrens ..	South Australia..	Recent Pleistocene ..	4,000	Up to 600
Coastal Plain ..	Western Australia	Recent Jurassic ..	10,000	200 to 2,500
Adelaide ..	South Australia..	Recent Oligocene ..	1,100	100 to 500
Gippsland ..	Victoria ..	Pleistocene-Oligocene	1,800	200 to 1,800
Port Phillip ..	Victoria ..	Pleistocene-Oligocene	300	Up to 600
Eucla.. ..	Western Australia, South Australia	Pliocene-Miocene ..	68,000	300 to 2,000
North-west ..	Western Australia	Tertiary Permian ..	40,000	400 to 4,000
Collie ..	Western Australia	Permian	500	..
Desert ..	Western Australia	Permian	130,000?	200 to 3,000

More than 3,000 artesian bores have been constructed within the Great Artesian Basin and the daily free discharge from all bores continuing to flow in Australia has been stated to exceed 350 million gallons, of which the loss by evaporation and seepage has been estimated at more than 90 per cent. Sub-artesian bores and wells throughout Australia number more than 200,000.

Artesian water generally is good stock water, but it is unsuitable for plant life; while in certain areas sub-artesian waters are suitable for all uses including irrigation. In some districts a considerable amount of irrigation is carried out from shallow ground water supplies.

In common with other countries possessing artesian supplies, Australia has been faced with the problem of flow diminution. It was recognized early that flows were diminishing as more bores were drilled, but it is now considered that while many of the bores will ultimately cease to flow, many will not cease, but will assume a perpetually steady rate of flow, corresponding with the average intake of water from rainfall absorbed by sandstone outcrops. Diminution in flows from artesian bores has emphasized the need to eliminate wastage as much as possible, and investigations have been made regarding wasteful methods of distribution of artesian water by open channels or " bore drains " and the careless use of water. (For greater detail on this subject *see* Official Year Book No. 37, pp. 1103–4.)

(iii) *Ground Water.* Ground water supplies are used in various parts of Australia for industry, irrigation, stock and domestic purposes the most notable scheme being that conducted by the Hunter District Water Board where ground water from the Tomago sandbeds near the mouth of the Hunter River, New South Wales is used to supplement water storages fed from surface sources. For further information on ground water *see* Official Year Book No. 37, p. 1104.

7. **Industrial, Metropolitan and Country Town Supplies.**—Details relating to urban water supply systems will be found in Chapter XV.—Local Government of this Year Book.

§ 3. National and Interstate Aspects.

1. **General.**—As the government of Australia is conducted under a Federal system, and as the Commonwealth Constitution makes special reference to water problems, both the Federal and the State Governments have an interest in the control and conservation of water. As main responsibility for control of water resources resides in the State governments, and as political boundaries sometimes intersect river valleys and catchments, co-operation between governments has been necessary to develop resources in certain cases. Specific examples of Commonwealth–State and interstate co-operation and approach are given in the following sections.

In the Report on Irrigation, Water Conservation and Land Drainage presented to the Commonwealth Government by the Rural Reconstruction Commission in 1945 national aspects of water conservation and use were emphasized. The report recommended the adoption of an all-Australian plan, having the assent of the various governments, to obviate lack of co-ordination, and that the Commonwealth should endeavour to promote interstate co-operation and co-ordinated development generally.

Following a resolution of the Australian Agricultural Council, the Irrigation Production Committee was established in 1938 for the purpose of carrying out comprehensive investigations into the various agricultural activities of lands irrigible by the River Murray and its tributaries in order to co-ordinate developmental activity there, but its work was interrupted by the war. Resuscitated in 1946 as the Irrigation Production Advisory Committee, and representative at first of the Commonwealth and the States of New South Wales, Victoria and South Australia, and later also of such other States as desired representation, with the Commonwealth Director-General of Agriculture as chairman, its functions are:—(*a*) to prepare for the consideration of the Australian

Agricultural Council, or any Committee of Ministers appointed by the Council, conclusions formed from investigations to be carried out by Commonwealth and State Officers into the various agricultural industries which it is possible to develop on irrigated lands; (*b*) to undertake long-term co-ordination of land utilization in irrigible areas served by the River Murray and its tributaries, this involving co-ordination of all available lands and the carrying out of such supplementary investigations as may prove necessary.

2. **Murray River Scheme.**—(i) *General.* The Murray River and its tributaries form the largest river system in Australia. The catchment is approximately 414,000 square miles or one-seventh of the area of the Australian continent, comprising five-sixths of New South Wales, over one-half of Victoria, one-sixth of Queensland, and one-fortieth of South Australia. The Murray proper is 1,600 miles long. Its main tributaries are the Murrumbidgee (1,050 miles), the Darling (1,760 miles), and the Goulburn (280 miles). The average annual flow of each of the chief contributory streams is as follows :—Upper Murray, including the Mitta Mitta and Kiewa Rivers, 3,400,000 acre feet; Murrumbidgee River, 2,600,000 acre feet; Goulburn River, 2,250,000 acre feet; Darling River, 2,150,000 acre feet; and Ovens River, 1,200,000 acre feet. Irrigated production in the River Murray basin is mainly in the form of wine, dried fruits, fresh fruits, dairy produce, wool, fat lambs, rice, vegetables, poultry, eggs and pigs.

For a brief summary of the historical events leading up to the River Murray Agreement (1915) by the Governments of the Commonwealth, New South Wales, Victoria, and South Australia *see* previous issues of the Year Book. The Agreement provided for the construction of works, the allocation of the water between the three States, and the appointment of a Commission to implement the Agreement. The Commission comprises four Commissioners, representing the Commonwealth and the three States respectively. The Commonwealth representative presides.

(ii) *River Murray Waters Agreement.* Under the Agreement construction works are carried out by the States (who are also responsible for maintenance) subject to the approval and direction of the Commission. The Agreement provides that the minimum quantity of water to be allowed to pass for supply to South Australia in each year shall be sufficient to fill Lake Victoria storage once, and with the aid of water returned from Lake Victoria, to maintain certain specified flows in the lower river varying from 47,000 acre feet per month in the winter months to 134,000 acre feet per month in the four summer months of maximum demand—the total amounting to 1,254,000 acre feet over twelve months. These flows are to meet domestic and stock requirements in South Australia, losses of water in lockages and evaporation losses other than in the lakes at the Murray mouth, together with 603,000 acre feet per annum for diversion from the Murray for irrigation in South Australia. The flow at Albury is shared equally by New South Wales and Victoria, and each of these States has full control of its tributaries below Albury, subject in each case to the fulfilment of the South Australian allocation.

Under the original agreement the major works comprised two large storages—one on the Upper Murray above Albury (the Hume Dam) and the other at Lake Victoria in New South Wales near the South Australian border. In addition, provision was made for a number of weirs and locks along the Murray and Murrumbidgee Rivers. In 1934 the Agreement was varied to provide for the construction of a diversion weir at Yarrawonga (145 miles downstream from the Hume Dam), and the provision of barrages at the mouth of the River to prevent the entry of salt water. The amendment also limited the original proposal for 26 weirs and locks on the Murray and 9 on the Murrumbidgee to 13 on the Murray and 2 on the Murrumbidgee. At the same time it was agreed that the Hume Dam should be completed to a capacity of 1,250,000 acre feet with provision for later increase to 2,000,000. As a result of the amendment, continuous navigation is limited to a route of 600 miles, extending from the mouth to a point some 50 miles above Mildura. All works authorized under the amended Agreement (except the enlargement of the Hume Dam to 2,000,000 acre feet) have been carried out at a total cost of £12,000,000, of which approximately half represents the cost of the Hume Dam. Expenditure has been shared equally by the Commonwealth and the three States.

At a Ministerial Conference held in October, 1948, the four parties to the Agreement resolved that the enlargement of the Hume Reservoir to 2,000,000 acre feet and the

doubling of the capacity of the inlet channel to Lake Victoria storage should be proceeded with immediately at a further estimated cost of £2,000,000. The resolutions of the Conference were subsequently incorporated in an amending agreement which was ratified by legislation by all parties. Under the terms of the amending agreement, the States of New South Wales and Victoria are required to report annually on the condition of the Hume Reservoir catchment and to take any special action recommended by the River Murray Commission in regard thereto. The River Murray Commission has also power to initiate proposals for the better conservation and regulation of the waters of the Murray, and may cause surveys and investigations concerning such proposals to be undertaken.

At the Conference of Ministers held in July, 1949, to consider the diversion of the Snowy River, Conference decided that, by diversion of streams in the Snowy Mountains area, an average of approximately 400,000 acre feet per annum would be added to the Murray River. Although a minimum storage of 250,000 acre feet would be necessary to regulate this additional water, Conference considered it would be unwise to limit to this capacity any storage which might be constructed, and felt that a storage of not less than 1,500,000 acre feet should be provided, in order to give additional regulation of the Murray River itself as well as to provide for regulation of the diverted waters. Hydro-electric potentialities would also affect the size of the storage.

It was agreed, therefore, to ask the River Murray Commission to investigate the position and to determine the optimum size of the proposed storage it considered should be constructed and also its location. Investigations into the hydrographic aspects of the maximum practicable regulation of the waters of the Upper Murray, including diversions from the Snowy River, have been undertaken and the results are now under consideration by the Commission. Investigations into the hydro-electric potentialities are also in hand.

The total estimated quantity of water diverted in 1949–50 for irrigation and other purposes from the Murray and its tributaries (under the River Murray Agreement) was as follows (in acre feet): —New South Wales, 1,029,257; Victoria, 1,429,524; South Australia, 182,560; a total of 2,641,341 acre feet.

(iii) *River Murray Works.* One of the major works of the Murray River Scheme is the Hume Dam, situated just below the junction of the Murray and Mitta Mitta Rivers, 10 miles above Albury, forming a lake of 33,000 acres. The design comprises a mass concrete spillway and outlet works extending 1,000 feet and an earthen embankment 106 feet high extending for 4,000 feet across the river flats. The length of the total structure is approximately 1 mile. Ultimate plans include provision for hydro-electric generation, and preliminary works associated with the construction of the power station are now in hand. Attention is also being given to the completion of the dam to its designed capacity of 2,000,000 acre feet and also to the enlargement of the inlet channel to Lake Victoria, necessary to permit greater storage of periodic flood flows of short duration.

The Yarrawonga Diversion Weir was completed in 1939 to raise the river level so that water could be diverted by gravitation into main channels constructed on either side of the river. Between the Yarrawonga Weir and the Murray mouth, thirteen weirs and locks have been built. Two flood diversion weirs have been constructed on the Murrumbidgee—one between Hay and the Lachlan Junction; and the other below the Lachlan Junction.

The Mulwala Canal, served by the Yarrawonga Weir, has an off-take capacity of 2,500 cubic feet per second, and will serve 1,500,000 acres of land in New South Wales. The Yarrawonga Channel, on the Victorian side, has an off-take capacity of 1,250 cubic feet per second, and is designed to serve 270,000 acres. Only a portion of both these areas will be irrigated.

Adjoining the river in New South Wales and 35 miles from the Murray-Darling Junction, Lake Victoria storage was completed in 1928 with a capacity of 551,700 acre feet and a surface area of 27,670 acres. The water released from Lake Victoria is used by the South Australian settlements.

Five barrages across channels near the Murray River mouth connecting Lake Alexandrina with the sea were completed in 1940 to prevent ingress of salt water to Lakes Alexandrina and Albert and to the lower river, thereby increasing the productivity of adjacent lands. The structures maintain a sufficiently high level for 50 miles up river to permit watering by gravitation of a considerable area of reclaimed river flats. The total distance across the barrages and intervening islands is 15 miles.

In addition to the works carried out under the auspices of the Commission, the separate States have constructed thousands of miles of distribution channels and provided a number of storages on the tributaries, thereby contributing very materially to the large amount of irrigation development in the Murray Basin. The total capacities of such main storages are: New South Wales—Burrinjuck (Murrumbidgee), 771,640 acre feet; Wyangala (Lachlan), 303,900 acre feet; Victoria—Eildon (Goulburn), 306,000 acre feet (now being increased to 2,750,000 acre feet); Waranga (Goulburn), 333,400 acre feet. No storages exist on the Murray in South Australia. More details of these and other State works on Murray tributaries will be found in the sections dealing with State systems.

3. **New South Wales-Queensland Border Rivers Agreement.**—The New South Wales–Queensland Border Rivers Agreement provides for the construction of certain works on parts of those portions of the Severn, Dumaresq, Macintyre and Barwon Rivers which constitute part of the boundary between New South Wales and Queensland, for the furtherance of water conservation, water supply and irrigation in those States. The Agreement, which was ratified by the Parliaments of both States, was executed on 27th November, 1946 and came into effect on 1st July, 1947. However, the Dumaresq-Barwon Border Rivers Commission, which is charged with the duty of giving effect to the Agreement and the ratifying Acts, was not constituted until 1st May, 1948.

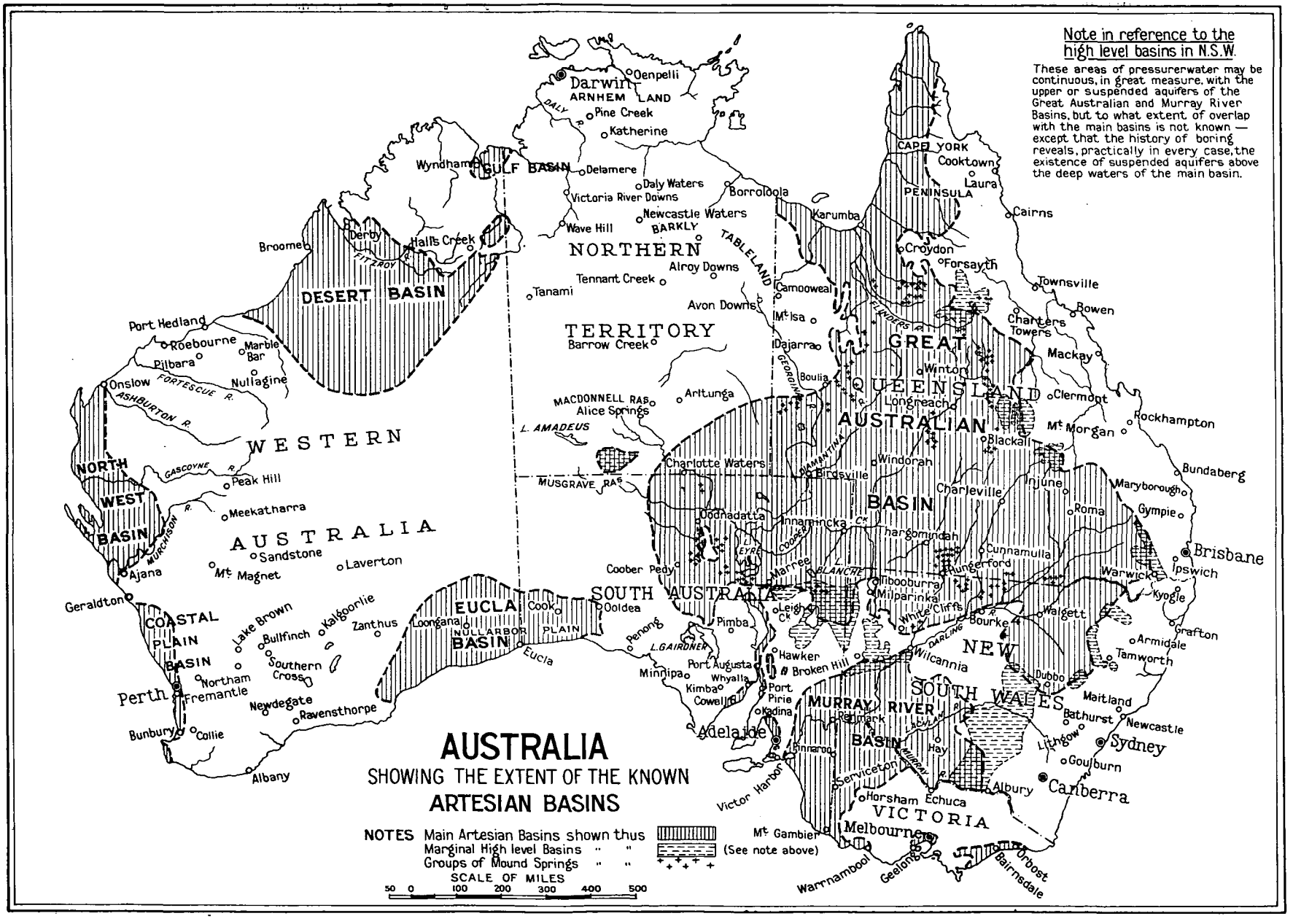
The works to be constructed comprise a dam on the Dumaresq River at a site to be selected by the Commission to give a storage basin with a capacity as large as is reasonably practicable and not less than six nor more than twelve weirs as may be found necessary to meet the requirements of irrigation along the rivers. Provision is also made for the construction of not more than four regulators in the effluents from the barrier rivers and for the taking over of the existing weir in the Macintyre River at Goondiwindi and the existing weir in the Barwon River at Mungindi. The costs of these works and of administration are to be borne by the States in equal shares. The agreement further provides that the water discharged from the Dumaresq storage, whether by regulated or unregulated flow, shall be available to the two States in equal shares.

The Water Conservation and Irrigation Commission of New South Wales, which is the constructing authority for the dam, has for some time past been carrying out investigations of alternate dam sites on the Dumaresq River near Mingoola Station Homestead which is approximately 39 miles from Tenterfield. Although well advanced, these investigations have not proceeded sufficiently far to enable the Border Rivers Commission to determine the most suitable site, the height of the dam wall or the capacity of the storage.

The Irrigation and Water Supply Commission of Queensland, which is the constructing authority for the new weirs and regulators, has carried out detailed investigations as to sites for such works. The Border Rivers Commission authorized construction of a weir on the Dumaresq River near Bonshaw, known as the Bonshaw Weir, and work has been in progress since June, 1949. Owing to abnormal flood conditions in the river and difficulty experienced in obtaining plant and materials, construction has not yet been completed.

The Border Rivers Commission has also authorized the construction of a further weir, to be known as the Cunningham Weir, at a site at mileage 42.25 in the Dumaresq River, but work has not been commenced owing to the difficulty in obtaining technical staff, plant and materials. Investigations are proceeding in regard to the remaining weirs and regulators. The existing Goondwindi and Mungindi Weirs have been taken over and are being maintained, operated and controlled by the Queensland Irrigation and Water Supply Commission.

The catchments for the border streams (2,000 square miles) extend to the granite areas in the vicinity of Tenterfield (New South Wales) and Stanthorpe (Queensland), and elevation rises to 3,000 feet. Average rainfall is 30 inches. The catchments and the



This map was re-drawn from that published in the Report of the Fifth Interstate Conference on Artesian Water, Sydney, 1928.

areas suitable for irrigation are approximately equal in each State. Climatic conditions are such that it is necessary to supplement rainfall from April to October by irrigation to stabilize and increase production. The capacity of the area to grow lucerne and tobacco under irrigation has already been demonstrated. Irrigation of cotton, root crops, cereals, and citrus fruit, and expansion of the fat stock industry, is being examined.

4. **Snowy Mountains Hydro-electric Scheme.***—(i) *General.* Following a comprehensive investigation into both the water and power potential of the Snowy River waters by a Technical Committee representative of the Commonwealth and the States of New South Wales and Victoria in 1947 and 1948, and the submission by the committee of reports in 1948 and 1949, the Commonwealth Parliament in July, 1949 passed the Snowy Mountains Hydro-electric Power Act (No. 25 of 1949) setting up an Authority to implement the proposals agreed upon.

The basis of the proposals is to impound the Snowy River waters at high elevations and, by diverting them into tunnels passing under the Alps, to use their potential power for the generation of electricity and then to discharge them into the Murray and Murrumbidgee River systems for use in the irrigation areas.

The scheme will be constructed in two parts, the first being known as the Snowy-Murray system, where the water is to be diverted by tunnel from a large dam across the Snowy River at Jindabyne, to the Swampy Plains River in the Murray Valley; and the second as the Snowy-Tumut system, the water in which will be diverted by tunnel from a dam on the Eucumbene River—a tributary of the Snowy—at Adaminaby, to the Tumut River, a tributary of the Murrumbidgee. The whole scheme will involve the construction of:—seven major dams (with a total storage capacity of approximately 7,000,000 acre feet); sixteen power stations; 86 miles of tunnels varying in diameter from 18 feet to 42 feet—one projected tunnel 30 miles long under the Alps will be one of the largest in the world; nearly 500 miles of racelines at high elevations.

The total expenditure is estimated at £225,000,000 including £100,000,000 for transmission lines. The scheme will form the greatest engineering and developmental work ever undertaken in Australia and one of the major engineering projects of the world.

(ii) *Snowy Mountains Hydro-electric Power Act* 1949. The Snowy Mountains Hydro-electric Authority is constituted by a Commissioner: he is assisted by two Associate Commissioners. The functions of the Authority are defined in the Act as follows:—(*a*) to generate electricity by means of hydro-electric works in the Snowy Mountains area and (*b*) to supply electricity so generated to the Commonwealth (i) for defence purposes and (ii) for consumption in the Australian Capital Territory. The general powers of the Authority as defined in the Act are as follows:—For the purpose of performing its functions the Authority shall have power to construct, maintain, operate, protect, manage and control works—(*a*) for the collection, diversion and storage of water in the Snowy Mountains Area; (*b*) for the generation of electricity in that area; (*c*) for the transmission of electricity generated by the Authority; and (*d*) works incidental or related to the construction, maintenance, operation, protection, management or control of any of the works specified above. The Act provides that the Authority may sell to a State, or to an authority of a State, electricity generated by the Authority which is not immediately required by the Commonwealth for defence purpose or for consumption in the Australian Capital Territory.

(iii) *The Authority's Objectives and Programme.* The two basic objectives are—(*a*) early production of electricity; and (*b*) early diversion of water inland.

(NOTE.—The following information was furnished in September, 1951.)

The Authority is expanding its day-labour forces to undertake types of work which are unsuitable for execution by contract, and, so as to reduce to a minimum the demand on local resources, is procuring from overseas most of its professional staff and skilled and unskilled labour and materials in local short supply. The Authority's personnel on 1st August, 1951, was as follows:—Professional staff, 260; other technical staff, 140; administrative and accountancy officers, 350; skilled and unskilled labour, 2,000.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 1154-7.

The Department of Public Works, New South Wales, has undertaken the design and construction of Adaminaby Dam, and the Department of Main Roads, New South Wales and the Snowy Shire have undertaken the reconstruction of over 70 miles of existing roads. A large proportion of the building construction now in hand is being carried out by oversea contractors who import prefabricated sections of the buildings and the labour to erect them. A contract has been placed with an oversea firm for the design and construction of the complete Guthega Project on the Upper Snowy River. The contractor will bring his staff, labour, construction equipment and material from overseas. For some detail of the preliminary work of the Authority *see* previous issue of the Year Book.

(iv) *Development of Power.* It is anticipated that the first instalment of power, estimated at approximately 60,000 kW., will be available by 1954, and additional generating capacity is scheduled to become available gradually up to over 500,000 kW. by 1959.

B. STATES AND TERRITORIES.

§ 1. Australian Local Pattern of Water Conservation and Use.

The foregoing sections dealt generally with water conservation and irrigation in Australia and with national and interstate projects. The following survey indicates the local pattern of water resources and the steps taken by State Governments to bring about their development. It will be seen that water policies in the various States tend to assume a distinctive and characteristic pattern closely allied with climatic conditions and specific local needs.

In Victoria almost every form of water scheme is in operation. In New South Wales major emphasis at present is on irrigation and stock development in the dry areas along the Murray and Murrumbidgee Rivers, though a substantial scheme of intensive irrigation is being conducted in the Murrumbidgee Irrigation Areas. In Queensland, up to the present, the predominant emphasis has fallen on water for the stock industries (mainly underground sources), and the development of small irrigation schemes in sub-humid and humid areas, especially to stabilize sugar production.

Apart from regular irrigation practices along the Murray River, South Australian authorities are vitally concerned with reticulated supplies for rural areas and towns. Western Australia has developed unique rock catchments and piped supplies for agricultural areas and towns in dry districts. Tasmanian interest appertains to hydro-electric generation almost exclusively. The Northern Territory is primarily concerned with stock supplies and the safeguarding of long stock routes.

§ 2. New South Wales.

1. **General.**—(i) *Rainfall and History.* In issue No. 37 of this publication (p. 1110) information on the pattern of rainfall and the history of irrigation in New South Wales preceded the description of water conservation and use in that State, but it has now been omitted. Chapter II.—Physiography, of this issue, however, contains particulars of climatic conditions in each State.

(ii) *Administration.* Under the amendment of the Irrigation Act, made by the Conservation Authority of New South Wales Act, 1949, which came into force on 1st July, 1949, the Water Conservation and Irrigation Commission of New South Wales now consists of three members appointed by the Governor, one of whom is appointed as Chairman. The operations of the Commission cover water conservation, control of irrigation areas, establishment, operation and maintenance of works for domestic and stock water supply, irrigation districts, flood control districts, sub-soil drainage districts, constitution of water trusts, the issue of licences for private irrigation, artesian and shallow boring, and a farm water supply scheme.

Under the Water Act the right to the use and flow, and the control of water in all rivers and lakes which flow through, or past, or are situated within, the land of two or more occupiers, is vested in the Crown. A system of licences also operates for the protection of private works of water conservation, irrigation, water supply, drainage, and prevention of inundation.

For particulars of the New South Wales–Queensland Border Rivers Agreement ratified by Acts of both States in 1947 *see* page 1210 *ante*.

2. **Schemes Summarized.**—(i) *Location and Type.* The bulk of irrigated land is along the Murray and its tributary the Murrumbidgee. Smaller areas are served by the Wyangala Dam on the Lachlan, another tributary. None of the other rivers is regulated by large head storages, though weirs and dams have been provided for town supplies, etc., in many places, and head storages have been commenced on the Macquarie, Namoi and Hunter Rivers. Substantial use is made of artesian and sub-artesian water in pastoral areas.

New South Wales legislation provides for the constitution and control of various schemes having different characteristics and including Irrigation Areas, Irrigation Districts, Water Trust Districts, and Flood Control and Irrigation Districts. There are five Irrigation Areas :—The Murrumbidgee Irrigation Areas consisting of 403,256 acres served with water through a channel system off-taking from the river at Berembed Weir ; the Coomealla Irrigation Area of 35,450 acres, served by pumping from the Murray ; the Curlwaa Irrigation Area of 10,243 acres, supplied from the Murray by pumping ; the Hay Irrigation Area of 6,806 acres, supplied with water pumped from the Murrumbidgee; and the Tullakool Irrigation Area of 16,305 acres supplied from the Edward River at Stevens Weir. All these areas are administered by the Commission, and details of the various schemes are given in sub-section (iii) hereinafter.

(ii) *Works.* The capacities of the main storages (in acre feet) are :—

Murray:—Half share of Hume Dam, weirs and locks to Wentworth (736,420); Stevens Weir, Edward River (7,165).

Murrumbidgee:—Burrinjuck Dam (771,640) ; Berembed Weir (10,000) ; Maude Weir (6,740) ; Redbank Weir (7,360).

Lachlan:—Wyangala Dam (303,900) ; Lake Cargelligo (29,435) ; Jemalong Weir (1,790) ; Lake Brewster (108,000)—works almost complete.

Water from the Hume Dam is used for domestic and stock purposes, to provide bulk supplies for country towns, for the irrigation of vines, fruits and fodder in the Curlwaa and Coomealla areas, for domestic and stock supply and irrigation in the Berriquin, Wakool and Denimein Districts, and for water trusts for domestic and stock purposes and/or irrigation.

The Wyangala Dam is 30 miles upstream from Cowra in the Central West. It has a catchment of 3,200 square miles. Water from the dam, supplemented by the unregulated flow of the Belubula River, provides for domestic and stock purposes along the full length of the river (over 700 miles) and also for irrigation by land holders operating licensed pumps. The towns of Cowra, Forbes, Condobolin, Hillston and Booligal are supplied. A balance storage at Lake Cargelligo conserves water during periods of high flow for release as required. Water from the Lachlan, diverted at Jemalong Weir, supplies the districts of Jemalong and Wyldes Plains, serving an area of 225,196 acres. Wyangala is now producing hydro-electric power. Proposals for future development include provision of a head storage at Belubula River, the construction of a balance storage of 108,000 acre feet at Lake Brewster (now almost complete) and development by licensed diversions.

The approximate total length of channels (including main canals) in New South Wales is 2,630 miles. The approximate length of drains and escape channels is 930 miles, and approximate total length of pipe lines is 10 miles, making a grand total of 3,570 miles of channels and pipe lines, etc.

(iii) *Extent of Systems and Nature of Irrigated Culture.* The following table shows the areas of the various irrigation systems and the areas under irrigated culture in New South Wales during 1950–51, the latter according to the nature of irrigated culture.

AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE: NEW SOUTH WALES, 1950-51.

(Acres.)

System, etc.	Total Area.	Area under Irrigated Culture.										
		Rice.	Other Cereals Grown for Grain.	Lucerne. (a)	Pastures. Other Fodder Crops.	Pastures. Sown. (b)	Pastures. Natural.	Vineyards.	Orchards. (c)	Vegetables.	Fallow and Miscellaneous.	Total.
Irrigation Areas—												
Murrumbidgee (within the Areas) ..	403,256	22,667	27,946	4,713	2,316	36,153	5,132	5,624	14,045	3,718	31,359	153,673
Lands adjacent supplied under agreement	(d)	60	..	..	..	5,120	2,570	..	..	..	60	7,810
Coomealla	35,450	..	..	23	164	..	..	2,476	252	19	..	2,934
Curlwaa	10,243	..	..	37	67	..	541	682	875	11	..	1,726
Hay	6,806	..	..	97	309	1,007	28	..	..	..	20	(e) 1,461
Tullakool	16,305	2,256	3,694	20	85	478	..	..	..	..	280	6,813
Total	472,060	24,983	31,640	4,890	2,941	42,758	7,784	8,782	15,172	3,748	31,719	174,417
Irrigation Districts—												
Beneremban ..	111,586	3,267	6,605	1,299	850	16,455	50	..	..	17	1,568	30,111
Tabbita	5,980	83	870	..	12	645	12	..	..	..	..	1,622
Wah Wah	583,111	..	2,220	310	290	3,220	150	..	..	..	300	6,490
Berriquin	654,050	..	7,353	11,445	2,439	86,096	12,167	..	..	188	7,109	126,797
Wakool	486,192	8,890	1,717	918	644	25,735	3,707	..	..	25	2,030	43,666
Jemalong and Wyldes Plains	225,196	..	600	1,047	87	2,065	4,400	..	..	..	395	8,594
Denimein(f) ..	156,830	..	422	317	129	1,660	2,207	..	..	10	42	4,787
Gumly	329	..	..	..	..	..	..	..	..	..	..	..
Total .. .	2,223,274	12,240	19,787	15,336	4,451	135,876	22,693	..	..	240	11,444	222,067
Flood Control Districts—												
Lowbidgee	375,000	..	..	..	..	..	(g)94,828	..	..	..	..	(g)94,828
Medgun	272,800	..	..	..	..	..	(g)58,960	..	..	..	..	(g)58,960
Total	647,800	..	..	..	..	..	g 153,788	..	..	..	..	g 153,788
Irrigation Trusts—												
Pomona	1,241	..	..	..	..	..	..	409	125	..	..	534
Blairmore	315	..	..	..	..	..	..	..	..	..	..	(d)
Bringan	4,933	..	100	100	..	..	1,035	..	35	2	..	1,272
Bungunyah–Koraleigh	1,804	..	..	..	..	..	..	1,057	64	45	..	1,166
Glenview	661	..	..	180	..	..	178	..	62	7	..	427
Goodnight	1,167	..	..	..	4	..	..	556	40	7	..	607
Bama	3,446	..	..	..	..	..	..	..	..	..	..	(d)
Total	13,567	..	100	280	4	..	1,213	2,022	326	61	..	4,006
Water Trusts—Domestic and stock supplies ..	2,945,068	..	..	..	..	..	..	..	..	..	..	..
Licensed Diversions(h)— To irrigate	(d)	..	..	6,450	3,962	13,605	4,988	888	1,987	11,405	(i) 210	43,495
Grand Total(j) ..	..	37,223	51,527	26,956	11,358	192,239	k 190,464	11,692	17,485	15,454	43,373	k 597,773

(a) Includes grazing and cutting. (b) Perennial and annual self-seeding. Perennial amounted to 10,999 acres of which 6,000 acres were in the Berriquin Irrigation District. (c) Citrus and deciduous. Deciduous amounted to 8,131 acres, of which 7,703 acres were in the Murrumbidgee Irrigation Area. (d) Not available. (e) Includes 408 acres of dry area leases and land outside the Area supplied under special agreement. (f) Works incomplete. (g) Area irrigable; actual details of area irrigated are not available. (h) Excludes domestic and stock supplies for which particulars are not available. (i) Tobacco. (j) Incomplete. (k) Includes Flood Control Districts—*see* (g).

3. **Murrumbidgee Irrigation Areas.**—(i) *Description.* These areas comprise about a third of the State's irrigated acreage and in 1950–51 received 277,938 acre feet of the total water allocated for stock, domestic supply and irrigation (821,980 acre feet). They are served by the Burrinjuck Dam (capacity 771,640 acre feet), 40 miles north-west of Canberra, on the Murrumbidgee. The catchment above the dam is 5,000 square miles. The river rises on the high plateau north of Mount Kosciusko where rainfall exceeds 60 inches. Flow for the irrigation districts is supplemented by unregulated flow below the dam from the Tumut River. The dam also provides town supplies for Gundagai, Wagga, Narrandera, Hay, Balranald, and for towns served by the South-West Tablelands scheme.

Domestic and stock water and water for irrigation is supplied for the Irrigation Districts of Tabbita, Benerembah and Wah Wah and the flood irrigation districts of Lowbidgee. Flood flows are relied on to serve the Lowbidgee district and water is not released from the dam for that purpose. For the other undertakings, however, water is stored during the winter and spring freshets, fed by melting snows, and is released during the September-April irrigation season. It passes along the river channel to Berembed Weir, 240 miles westward, where it is diverted to the main canal with an off-take capacity of 1,600 cubic feet per second. The main canal has been completed to beyond Griffith, 96½ miles from the off-take. Reticulation channels aggregate 840 miles and drainage channels 810 miles.

In addition, 380 miles of supply channel run through adjacent irrigation districts in which the water supply is operated and maintained by the Commission, but land transactions are not under its control. The land on which the Murrumbidgee Irrigation Areas are situated originally comprised large sheep stations with a sparse population.

Population was 12,000 in 1923, 15,000 in 1929 and 20,000 at the 1947 Census. The population of the Yanco district (with Leeton as the centre) was then 9,000; and the population of the Mirrool Area (with Griffith at the centre) was 11,000.

(ii) *Administration.* The Water Conservation and Irrigation Commission controls land transactions and water supplies for the Murrumbidgee Irrigation Areas, also the distribution of electricity throughout those areas. Other local government services, including town water supply, are provided by Shire Councils. Land is disposed of by the Commission under freehold or perpetual lease tenure or leased for short terms for grazing or cultivation. The area under occupation at 30th June, 1951 was 342,379 acres, including 42,150 held for short lease grazing, agriculture, etc.

(iii) *Production.* Since the scheme was inaugurated in 1911 the value of total production has aggregated approximately £60,000,000. During the year ended 30th June, 1951, production was valued at £7,820,800.

Live-stock contributed £1,073,300 (comprising sheep, £871,300; cattle, £145,000; pigs, £57,000); wool, £2,028,000; and other products, £106,800.

Rice (£1,560,000), wheat and oats (£666,000) contributed a total of £2,226,000. Horticulture accounted for £1,649,000, comprising almonds, apricots, citrus, drying grapes, table grapes, wine grapes, figs and olives, peaches and nectarines, pears, plums and prunes, quinces and apples. The greatest individual contributions were made by grapes, £433,900, peaches and nectarines, £317,600 and citrus, £375,200.

The total value of all vegetables was £644,200, including root crops, £288,700, tomatoes, £145,700, peas and beans, £129,000, cabbages, cauliflowers, onions and other products. A total of £93,500 represented the value of miscellaneous products.

Rice growing was initiated on the Murrumbidgee Irrigation Areas in 1924. Since then, aggregate production from those areas and from the other localities mentioned hereunder has been approximately 1,022,000 tons, valued at about £13,700,000 to the grower. In 1950–51 total area sown was about 37,000 acres, including 26,000 acres on the Murrumbidgee Irrigation Areas and adjoining districts, 8,890 acres at Wakool and 2,256 acres at Tullakool. The total quantity of water delivered for the rice crops during the 1950–51 season was 215,616 acre feet. Water supplied for rice represents about two-thirds of the total delivered in the areas and a quarter of the water artificially supplied for irrigation in New South Wales. Before the war the rice crop was more than sufficient for Australian requirements. During and after the war the area planted was increased to the limit of water available. Rice has also been grown in the adjoining districts of Benerembah and Tabbita and in each of the years 1944, 1945 and 1946 some 4,000-odd acres were sown by the Water Conservation and Irrigation Commission at Wakool as a war-time project. Approval has been given for some rice to be grown by individual landholders

within the Wakool Irrigation District during and since the 1948–49 season : this arrangement, however, is of a temporary nature only. On Tullakool Irrigation Area rice growing is expected to become a regular feature of primary development ; 2,256 acres were sown during the 1950–51 season.

Co-operation is a prominent feature in the Murrumbidgee Areas. Co-operative organizations in the Mirrool section handle 300,000 bushels of fruit per year (compared with 54,600 in 1927–28. Sales turnover of the Leeton cannery in each of the past five years was over £1,000,000. Settlers and government agencies co-operate extensively in all matters relating to irrigation practice.

4. **Other Irrigation Areas.**—The Curlwaa, Coomealla, Hay and Tullakool Irrigation Areas follow the same administrative pattern as the Murrumbidgee Areas—that is, land transactions are administered by the Water Conservation and Irrigation Commission which also is responsible for operation and maintenance of works to supply water at rates determined by the Commission.

Curlwaa Area, on the Murray near Wentworth, consists of 10,243 acres of which 2,327 acres at 30th June, 1951, comprised irrigated holdings. Production consists of dried vine fruits, deciduous fruits and fodder crops of a total estimated value, in 1950–51, of £198,546.

Coomealla Area, 9 miles upstream from Curlwaa, comprises 35,450 acres of which 3,001 acres at 30th June, 1951 comprised irrigated holdings. Other land in the undeveloped part is leased for grazing. Production consists of vines and citrus of an estimated value, in 1950–51, of £335,583. Works are now under construction to provide 100 horticulture farms for ex-servicemen, 33 of whom were in occupation of their new holdings towards the end of 1951.

Hay Area, on the lower Murrumbidgee, consists of 6,806 acres, of which 1,114 acres are occupied as irrigated holdings. Annual production, valued in 1950–51 at £26,710, comprises dairy products, fat lambs, sheep, wool and fodders.

5. **Irrigation Districts.**—These Districts are set up under the Water Act for (*a*) domestic and stock water supply and (*b*) irrigation. They differ from water trusts as the cost of the works is not required to be repaid over a period, but annual charges are made by the State for water supplied to landholders. The following are the districts or provisional districts constituted and the areas of land benefited :—*Murray River*—Wakool District (completed) 486,192 acres, Berriquin Provisional District (almost complete) 654,050 acres, Deniboota Provisional District (in progress) 303,064 acres, Denimein Provisional District (in progress) 156,830 acres, Jernargo Provisional District (now to be included within the Berriquin District) 130,850 acres, Barramein Provisional District (domestic and stock supply only—works not yet commenced) 88,651 acres ; *Murrumbidgee River* (completed)—Benerembah District 111,586 acres, Tabbita District 5,980 acres, Wah Wah Provisional District 583,111 acres, Gumly Provisional District 329 acres ; *Lachlan River* (completed)—Jemalong and Wyldes Plains District 225,196 acres.

Since the completion of the Hume Dam several such districts have been established along the Murray to utilize the New South Wales share of the storage. Water is not available for the whole of the 5,000,000 acres adjacent to the Murray in New South Wales, and therefore the schemes are based on "extensive" irrigation—that is, water rights are allotted to holdings on the basis that only a portion of each holding (one acre in ten or twelve, etc.) will be irrigated, but additional water, when available, may be obtained by landholders. "Water right" means right to such a quantity annually of water, 12 inches deep, as will cover an area of one acre.

Water to serve Berriquin and Wakool Districts is diverted through a main canal which will be 100 miles long when completed. At 30th June, 1951, the total length of completed canal and channels was 774.4 miles, including Mulwala Canal 75.4 miles, Berrigan channel 22.2 miles, subsidiary channels 635.4 miles, escape channels 32.5 miles and cross drainage channels 8.9 miles. Off-take capacity of the Mulwala Canal is 5,000 acre feet per day. Ultimately the water will serve Deniboota and other districts for which works have yet to be completed.

Wakool, with 361 miles of channel, contains 226 holdings and it is expected that the area developed by irrigation will comprise about one acre in 13 of the total area. The total area irrigated in 1950–51 was 43,666 acres and water supplied was 91,509 acre feet. Crops comprised fodders, pastures, rice, cereals and vegetables, but sheep raising is the main industry.

Considerable subdivision has occurred within the Berriquin District and it is expected that the proportion of total area to be developed for irrigation will be considerably higher than in the case of Wakool. Total irrigated acreage was 126,797 at the 30th June, 1951. Sheep and wheat growing are main industries. The fat lamb industry is well developed and expanding. Dairying is making headway, and a butter factory has been established at Finley.

In the Benerembah, Tabbita and Wah Wah Districts, supplied from the channels of the Murrumbidgee Irrigation Areas, the quantity of water supplied during the 1950–51 season for irrigation, etc. was 63,438 acre feet, and the area irrigated was 38,223 acres, including rice and other cereals, pastures and fodder crops. The estimated value of production, included in the amount (viz., £7,820,800) for the Murrumbidgee Irrigation Area, was £1,104,300 including wool, live-stock, wheat and oats and rice.

For the same season 7,665 acre feet of water was supplied from the Lachlan River to irrigate a total area of 8,594 acres within the Jemalong and Wyldes Plains Districts. The total estimated value of production was £2,000,000 including wool and lambs £1,800,000, calves £68,000, wheat, £70,000 and lucerne, £29,000.

6. **Water Trust Districts, Irrigation Trusts and Flood Control and Irrigation Districts.**—The Water Act provides for the constitution of Trust Districts for domestic and stock water and irrigation and empowers the Commission to construct, acquire or utilize necessary works. When the works are completed they are handed over to trustees to administer. The trustees are elected by the occupiers of the land and act with a representative of the Commission. They are empowered to levy and collect rates covering the cost of the works repayable to the Crown by instalments and also the cost of operation and maintenance of the works. The rates are struck according to the area of land which benefits. The following water trusts—other than irrigation—have been constituted; the area in acres of each district is shown in parenthesis :—*Murray River*—Tuppal Creek (78,080), Bullatele Creek (68,320), Little Merran Creek (157,440), Poon Boon (32,985), Minnie Bend Flood Prevention (2,190); *Murrumbidgee River*—Yanko, Colombo and Billabong Creeks (1,001,210); *Lachlan River*—Torriganny, Muggabah and Merrimajeel Creeks (170,240), Condobolin West Weir (4,480), Marrowie Creek (295,040), Ulonga (71,655), Micabil Weir (11,500); *Miscellaneous*—Algudgerie Creek (9,760), Nidgery Weir (46,880), Great Anabranch of Darling River (995,200), Collarenebri town water supply (88)—making in all a total area of 2,945,068 acres. Thirteen of these trusts have been formed for the provision of water for domestic and stock purposes, one for a town supply and one for flood prevention.

Irrigation Trusts are established under the same Act and are administered by trustees in a similar way. The following are the Trust Districts (area in acres is shown in parenthesis) :—*Hunter River*—Blairmore (315); *Murray River*—Bama (3,446), Goodnight (1,167), Bungunyah-Koraleigh (1,804), Glenview (661), Bringan (4,933); *Darling River*—Pomona (1,241)—making in all a total area of 13,567 acres.

The Lowbidgee Provisional Flood Control and Irrigation District (375,000 acres) was constituted in 1945, being the first of its kind. Its purpose is to provide flood irrigation for pasture lands on the lower Murrumbidgee by water diverted from the Maude and Redbank Weirs. There are 44 holdings. Another district (Medgun near Moree in the North-West) is in operation. Its total area is 272,800 acres, and a levee is being constructed to extend flood irrigation to an area larger than that commanded by the original works.

7. **River and Lake, and Farm Water Supplies.**—During recent years the numbers of licences and permits issued to individuals to draw water from rivers and lakes for irrigation has increased substantially, especially along the coastal streams in sub-humid districts where the value of supplementary irrigation is becoming more recognized as a means of stabilizing production in lean months. There has also been a considerable increase along the Murrumbidgee and Lachlan.

The Farm Water Supplies Act was passed in 1946. Technical advice and assistance, and financial assistance are made available to aid individual farmers and groups of farmers to provide and improve water supplies for domestic, stock and irrigation purposes by means of wells, bores, excavated tanks, weirs or dams.

8. **Underground Water.**—Extensive use is made of artesian, sub-artesian, and shallow underground water. Eighty thousand square miles in the north and western portions are covered by the Great Artesian Basin. Eighty-one Bore Water Trusts and

twelve Artesian Wells Districts have been constituted. The Bore Trusts are administered in the same way as Water Trusts, but in Artesian Wells Districts settlers maintain the drains. Bore Trusts and Artesian Districts cover about 5,000,000 acres and water is distributed through 3,378 miles of open earth drains. The number of artesian bores giving a flowing or pumping supply at 30th June, 1951 was 946 and the estimated total daily flow from 538 flowing bores was 62,156,177 gallons. The estimated flow in 1914-15 was 99,350,000 gallons per day for 372 bores. The deepest bore is Boronga No. 2 (4,570 feet), which also has the greatest flow, namely, 1,115,360 gallons per day. Of the total number of bores sunk, 222 have been installed by the Government in connexion with public watering places, Bore Water Trusts or Artesian Wells Districts.

Since 1912 the Government has assisted settlers in shallow boring operations for which repayments are required over a period. To 30th June, 1951, the total constructed by the Commission's plants was 4,203 and their average depth was 297 feet.

9. **Future Programme.**—The programme of post-war development already in hand includes the provision of eighteen dams and storages, eight diversion weirs and flood mitigation and river protection works in various parts of the State. Construction has been commenced on head storages at Keepit on the Namoi, Glenbawn on the Hunter and Burrendong on the Macquarie, while legislation has been passed authorizing the construction of a flood control dam at Warkworth in the Hunter Valley and a conserving dam at Blowering on the Tumut River. The Menindee Lakes storage project—part of the scheme for conserving the waters of the Darling River—is well advanced. A balance storage at Lake Brewster on the Lachlan River is almost complete and is in operation. The Hunter River development concerns an exceptionally fertile coastal valley, forming the hinterland to Newcastle, where the annual rainfall is not heavy and variations from month to month are considerable. This is the first coastal scheme initiated in New South Wales. Total estimated capacity of all proposed new storages is 5,500,000 acre feet.

10. **Hydro-electricity.***—The largest hydro-electric installation in New South Wales is that located at Burrinjuck Dam on the Murrumbidgee River. It consists of two power stations aggregating 25,800 kW., the first of which commenced operation in 1929. High tension transmission lines connect these plants with the major inter-connected system of New South Wales at Goulburn and Canberra. The output of the plant is dependent on the release of waters for irrigation purposes.

The Nymboida hydro-electric scheme was opened in 1924 with an initial capacity of 800 kW. to supply Grafton, South Grafton and Ulmarra over a transmission line of 31 miles. The Nymboida power station is situated on a tributary of the Clarence River in northern New South Wales and now has a capacity of 5,600 kW. The station now operates in conjunction with a diesel station at Lismore and an associated transmission network to provide supply throughout the north-eastern area from Kyogle in the north to Kempsey in the south, a distance of some 200 miles north and south. In 1946 the system was interconnected with the Department of Railways system based on Newcastle. The Nymboida system is controlled by the Clarence River County Council.

The Bega Valley scheme was opened in 1944 to supply an area of 2,700 square miles extending from Bermagui to Eden. The power is derived from the waters of Rutherford Creek, a tributary of the Bemboka River, and the capacity of the present installation is 500 kW. Two 750 kW. generating units are to be installed in conjunction with a further development on George's Creek, another tributary of the same river, and a comprehensive programme of rural electrification has been initiated. This system is controlled by the Bega Valley County Council.

Wyangala Dam power station was brought into operation in 1947. This station, with an installed capacity of 7,200 kW., utilizes the irrigation waters released from the dam to generate electricity, and in addition is designed to provide an essential stabilizing feature in the transmission system between Burrinjuck and Lithgow, to which the station is inter-connected. The output of the station at any time is dependent on the release of water for irrigation purposes.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 1160-1 and 1164.

Major projects which are being investigated by the New South Wales Government include the hydro-electric development of the Clarence River at the Gorge and other locations, the hydro-electric development of the Shoalhaven River and the hydro-electric development of the Styx River, a tributary of the Macleay River.

The Clarence Gorge scheme, situated 140 miles from Brisbane and 240 miles from Newcastle, embraces not only hydro-electric development, but also may offer considerable benefits by reason of the flood mitigation effects of a large dam built at this location. Investigations have shown that a dam 245 feet high would impound 4,500,000 acre feet of water and would enable the production of more than 100,000 kW. of power. It is expected that eventually some 400,000 kW. of power might be obtained from the Clarence River and its tributaries.

The Commonwealth and States agreed in 1945 on hydro-electric development at the Hume Dam on the Murray River near Albury. Plans are already well advanced for the installation at this site of two 25,000 kW. water turbines and generators.

Investigations are also taking place into the possibilities of developing hydro-electric power in association with the Warragamba Dam which is being built for water supply purposes for the Sydney metropolitan area, at Keepit Dam which is being constructed for irrigation purposes on the Namoi River near Gunnedah, and at the Burrendong Dam which is to be constructed for irrigation purposes on the Macquarie River near Dubbo.

§ 3. Victoria.

1. **General.**—(i) *Rainfall.* Particulars of the rainfall pattern of Victoria were given on page 1117 of Official Year Book No. 37, and Chapter II.—Physiography, of this issue, contains information on climatic conditions in each State.

(ii) *Administration.* Although practical steps were taken to organize Victoria's water resources before the turn of the century, the passage of the Water Act in 1905 marked the commencement of sustained progress. The State Rivers and Water Supply Commission established by this Act is vested with the control of all irrigation, rural domestic and stock supplies, town water supplies and flood protection and drainage undertakings outside the Metropolitan area, with the exception of the irrigation area operated by the First Mildura Irrigation Trust and the town water supplies operated by locally constituted Waterworks Trusts or Local Governing Bodies.

The operations of the First Mildura Irrigation Trust and the various Waterworks Trusts and Local Governing Bodies, as well as the various Sewerage Authorities which control sewerage undertakings in country towns, are also subject to general supervision by the Commission.

2. **Systems Summarized.**—(i) *Works.* Since 1902, when a great drought emphasized the need for a concerted attack on water problems, the total capacity of water storages has increased from 172,000 to 1,975,780 acre-feet (including Victoria's share of the Hume Dam). By means of channels, bores, etc. one-fourth of the State is artificially supplied for stock and domestic purposes. Large areas, which would be largely unproductive without water, are now contributing to the State's wealth. The area actually irrigated has increased from 110,000 acres in 1906 to 716,051 in 1950–51, and irrigation channels command 2,086,565 acres.

The Commission controls 35 large reservoirs and 238 subsidiary storages. The capacities of the storages in acre feet within the various systems at 30th June, 1951 were as follows :—

Goulburn System :—Eildon Reservoir 306,000 ; Goulburn Weir, 20,700 ; Waranga Basin, 333,400 ; *Murray–Loddon System* :—Half share of River Murray Commission storages including Hume, Yarrawonga, Torrumbarry, Euston, Mildura and Wentworth, 736,420 ; Kow Swamp, Laanecoorie, Kerang-North-West Lakes, Lake Boga and Lake Cullulleraine, 148,210 ; total 884,630 ; *Wimmera–Mallee* :—206,860 ; *Maffra–Sale* :—106,040 ; *Coliban* :—62,730 ; *Werribee* :—34,900 ; *Bellarine Peninsula* :—10,850 ; *Mornington Peninsula* :—5,800 ; *Otway* :—1,080 ; *Miscellaneous* :—2,790 ; *Total* :—1,975,780.

Irrigation channels extend 4,708 miles, domestic and stock channels, 8,514 miles and drainage and flood protection channels, 2,083 miles, a total of 15,305 miles. In addition, the Commission controls 1,180 miles of piping, comprising 260 miles of mains

and 920 miles of reticulation. Farm holdings served with water total 40,948. Urban districts supplied by the Commission's channels and pipelines have a population of 152,320 persons in 130 towns, and a further 136 towns with a total population of 333,980 persons are supplied by Trusts under the supervision of the Commission.

To 30th June, 1951, the total capital expenditure on irrigation, rural water supply, country town water supply, and flood protection and drainage works amounted to £47,815,000, one-half of which was in respect of irrigation.

The total capital liability in respect of works under the control of the Commission at 30th June, 1951 was £40,534,000, of which £37,817,000 was borne by the State and £2,717,000 by water-users. Waterworks Trusts and local governing bodies had a total capital liability of £5,592,000 at 30th June, 1951, of which £2,676,000 was borne by the State and £2,916,000 by the Authorities.

(ii) *Extent of Systems and Nature of Irrigated Culture.* Although the area irrigated is less than 2 per cent. of the State, it yields approximately 11 per cent. of Victoria's rural production. The following table shows the areas of the various irrigation districts and the areas under irrigated culture during 1950–51 :—

AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE : VICTORIA, 1950–51.

(Acres.)

System.	Total Area.	Area under Irrigated Culture.									
		Cereals.	Lucerne.	Other Fodder Crops.	Pastures. Sown.	Pastures. Natural.	Vineyards.	Orchards.	Market Gardens.	Fallow and Miscellaneous	Total.
Goulburn	1,256,416	9,496	26,930	2,220	238,904	38,027	268	19,242	4,188	4,628	343,903
Murray—											
Torrumbarry Weir ..	378,420	8,442	7,520	1,271	112,076	53,204	4,727	2,011	1,722	4,480	195,453
Yarrawonga Weir ..	267,344	692	10,352	230	22,900	4,700	40	2,756	418	224	42,312
By Pumping ..	49,871	69	259	236	256	124	22,682	1,335	302	30	25,293
Total ..	695,635	9,203	18,131	1,737	135,232	58,028	27,449	6,102	2,442	4,734	263,058
Loddon and other Northern Systems ..	(a) 19,725	524	1,379	105	3,426	1,842	30	4,326	1,533	2,604	15,769
Southern Systems ..	70,789	22	1,718	205	23,817	834	..	490	4,564	751	32,401
Mildura and Private Diversions	(b) 44,000	6,019	6,314	830	18,971	3,107	14,835	5,045	3,184	2,615	60,920
Grand Total ..	2,086,565	25,264	54,472	5,097	420,350	101,838	42,582	35,205	15,911	15,332	716,051

(a) Area of Campaspe District only. (b) Area of First Mildura Trust District only.

(iii) *Production.* The influence of irrigation on Victorian production is illustrated by the following estimates, prepared by the Commission, of the value of production from irrigated areas :—1905–6, £500,000 ; 1925–26, £5,000,000 ; 1948–49, £17,900,000 ; 1949–50, £22,500,000. Detailed classification of the 1949–50 irrigation production estimates is as follows :—Live-stock—Dairying, £4,700,000 ; Beef and veal meats, etc., £1,140,000 ; Wool, lamb and mutton, £4,300,000 ; Pigmeats, £1,150,000 ; Poultry and eggs, £1,200,000 ; total Live-stock, £12,490,000. Horticulture—Vine fruits, £3,840,000 ; Citrus fruits, £640,000 ; Other fruits, £1,580,000 ; total Horticulture, £6,060,000. Vegetables and other primary products, £3,950,000.

3. **Goulburn System.**—The Eildon and Waranga Reservoirs, on the Goulburn River, supply half the irrigated acreage, and form the largest system in Victoria. Annual rainfall in the valley is only 18 inches and the annual discharge has varied from 567,000 acre feet in a drought year to 6,202,171 acre feet in a particularly wet season. Total regulated supply is 960,100 acre feet which will be practically doubled on completion of the Eildon Reservoir Enlargement programme.

Water from Eildon Reservoir flows down the Goulburn for 150 miles to the Goulburn Weir, which raises the summer level of the river about 45 feet to 408 feet above sea level,

where water is diverted to two main channels. The eastern main channel conveys water to four irrigation districts surrounding Shepparton and the western main channel fills Waranga Basin in addition to supplying the eastern portion of the Rodney Irrigation District.

Two main outlet channels issue from the Waranga Reservoir, one serving the Western part of the Rodney district; while the other serves districts as far west as Boort, and continuing to Beulah East, about 230 miles by channel from Waranga Basin or some 400 miles from Eildon, supplements the Wimmera-Mallee system.

Districts served comprise 202,400 acres east of the Goulburn; 608,350 acres between the Goulburn and Campaspe; 445,100 acres between the Campaspe and Loddon Rivers; and 79,900 acres west of the Loddon—a total of 1,335,750 acres. Main channels of the system have a total length of 213 miles and in addition there are 2,344 miles of distributaries, a total of 2,557 miles for the whole system.

The development of the fruit-canning industries in the Goulburn Valley is an index of the results of irrigation policy. Annual production from the Shepparton, Kyabram and Mooroopna canneries, together with that of city canneries—from Goulburn Valley fruit—amounts to an aggregate which represents 70 per cent. of Australia's total production of canned peaches, pears and apricots. Other main products of the Goulburn districts are fat lambs, fodders, wine and table grapes and dairy products.

4. **Murray River System.**—The waters of the River Murray are used to supply an area of more than 500,000 acres between Yarrawonga and Merbein, and channels totalling 1,450 miles are in service. The districts between Yarrawonga and Swan Hill, excepting Tresco, are supplied by gravitation and those down the river (Red Cliffs, Merbein, Nyah and Mildura) are supplied by pumping.

The Murray Valley Irrigation District, supplied from Yarrawonga, will serve 280,000 acres when completed. At 30th June, 1950, 450 miles of main and distributary channels were completed and supplied 190,000 acres west of Yarrawonga.

The gravitation system based on Torrumbarry Weir (52 miles downstream from Echuca) serves an area of 415,500 acres with 846 miles of supply channels. The weir raises the level of the river some 16 feet and enables water to be diverted throughout the year.

Red Cliffs Irrigation District comprises 31,000 acres. At present 12,000 acres are irrigated. This ranks first in importance among Victoria's pumping schemes. A system of main and distributary channels commands every holding in the district. The district, originally for soldier settlement, has been subdivided into 700 blocks. The area planted is composed mainly of vines and citrus. The first harvest (1924) returned 570 tons of dried fruit in addition to table grapes. The average harvest is now 18,000 tons of raisins, currants and sultanas as well as large quantities of grapes for dessert and distillation.

Merbein Irrigation District comprises 10,520 acres and contains 436 holdings averaging 24 acres each. A reticulated pipe system supplies the town of Merbein, and the pumps also supply the Yelta Waterworks District of 51,200 acres.

Nyah Irrigation District is supplied with water diverted from the Murray by a high-lift pumping plant, serving 3,840 acres in 220 holdings devoted mainly to orchards and vineyards.

5. **First Mildura Trust District.**—The First Mildura Irrigation Trust—which is the only Irrigation Trust operating in Victoria—controls an area of 44,000 acres, of which 13,000 acres are irrigated. This area irrigated includes 12,000 acres of vines, 900 acres of citrus trees and small areas of apricots, peaches, prunes, figs, almonds, olives, lucerne and other fodders. It produces approximately 15,000 tons of raisins, currants and sultanas each year. The irrigation water is pumped from the River Murray and distributed through 168 miles of channels.

6. **Wimmera-Mallee System.**—The Wimmera-Mallee scheme is regarded as the most extensive domestic and stock supply system in the world. The main supply is drawn from the Grampians storages with a capacity of 206,860 acre feet. Supplementary water is drawn from the Goulburn channels and the Loddon River. The system serves an area of 11,000 square miles or nearly one-eighth of the State, which is largely devoted to wheat and pastoral industries. Without the artificial supply of water, development would be meagre.

Once a year, in the winter or spring, a volume of 75,000 acre feet of water is distributed through 6,600 miles of open channel and some 3,000 miles of farm channels. It is the responsibility of farmers to provide storages sufficient in size to meet their stock and domestic requirements for the ensuing year. At least 16,000 tanks are served. In addition, forty-five towns with a total population of 40,000 obtain their water from the system. A total population of 80,000 depends upon the scheme. In the vicinity of Horsham and Murtoa, near the main storages, 3,000 acres are irrigated for soft fruits and pastures, but the limited water resources at present available will not permit any extension of irrigation.

The northern part of the system is affected by sand drifting into the channels, particularly in years of dry weather conditions, and the Commission is involved in substantial annual expenditures to remove this sand drift before the annual water distribution can be made. It is considered that this expenditure could be reduced by better farming methods, and efforts in this direction such as the sowing of rye-corn, and including the use of compulsory powers to prohibit the fallowing of land or burning of stubble within three chains of channels in light sandy country, have resulted in marked savings in maintenance costs.

7. **Farm Water Supplies.**—The Rural Finance Corporation Act 1949 is designed, *inter alia*, to give farmers an opportunity of establishing or improving domestic and stock water supplies on their farms. Water may be obtained from underground sources, from catchment and gully dams by diversion from existing streams and channels, by storage of sufficient water to meet a year's requirements and by installation of windmills or hydraulic rams.

A Farm Water Supplies Branch has been set up by the State Rivers and Water Supply Commission to advise farmers on farm water supply matters even if finance is not required. Comprehensive booklets entitled "Farm Water Supplies for Domestic and Stock Purposes" and "Farm Irrigation and Drainage" prepared by this Branch have been widely circulated to landholders.

8. **Underground Resources.**—A comprehensive survey of the underground water resources of Victoria has been commenced. It will compile records of bores in the Mallee, Wimmera and Glenelg regions, and provide a detailed description of the Murray Artesian Basin. Investigations have also been made into the underground water resources of local areas such as Orbost Flats, Llowalong Estate on the Avon River and at Bacchus Marsh where a number of observation bores have been installed.

The Murray Artesian Basin underlies an area of 107,250 square miles, of which 26,808 square miles are in Victoria, 28,269 square miles in South Australia and 52,173 square miles in New South Wales. The quality of the water varies in different parts of the basin. Over 300 bores exist in Victoria, with an average daily flow of 3,000,000 gallons. Bores range in depth from 50 to 3,000 feet.

9. **Future Programme.**—Victoria has now reached the stage when the demand for water is far greater than the supply, and a programme which envisages an expenditure of £25,000,000 has been launched. This includes the Rocklands storage on the Glenelg River (272,000 acre feet) and the Cairn-Curran Reservoir on the Loddon (120,000 acre feet). Work has been commenced on the enlargement of the Eildon Reservoir on the Goulburn from 306,000 to 2,750,000 acre feet by the building of a large earthen embankment 260 feet high and 3,300 feet long at an estimated cost of £12,000,000. This would be Australia's greatest storage.

10. **Hydro-electricity.***—The Kiewa project in the Australian Alps is one of the largest hydro-electric developments in Australia. The authority responsible for its construction and operation is the State Electricity Commission of Victoria. The Kiewa River is a tributary of the Murray. The Victorian State Parliament in July, 1948, authorized the enlarged Kiewa project comprising a series of power stations with a total installed capacity of 289,000 kW. and an average output over wet and dry years of 1,000 million kWh. of electricity per annum.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 1168 and 1180.

Work is now in progress on this major undertaking of the State Electricity Commission. Electricity will be transmitted over a 220,000 volt power line 152 miles long to terminal stations in Melbourne for distribution throughout the Commission's supply network.

The first of the Kiewa power stations has been operating since 1944. Its installed capacity is 26,000 kW. and it is contributing annually between 40 and 50 million kWh. of electricity to the State system. The remaining power stations to be built will come into operation as and when they are completed.

The Kiewa hydro-electric undertaking is one of the principal developments in the State Electricity Commission's present construction programme. It will be complementary to the Commission's brown coal burning power station at Yallourn, which at present generates approximately 43 per cent. of all the electricity produced in Victoria and is now being extended to double, and later treble, its present capacity and output.

Further utilization is to be made by the State Electricity Commission of irrigation waters from the Goulburn River by the erection of a very much larger power station of 120,000 kW. capacity, which will operate on the increased flow of water from the new Eildon Reservoir now being constructed by the State Rivers and Water Supply Commission of Victoria (*see* above). Orders have been placed for the two 60,000 kW. generators which are to be installed.

Irrigation waters from the existing Eildon Reservoir are already utilized to operate the 13,500 kW. Sugarloaf power station, which is the largest power station in the State Electricity Commission's Sugarloaf-Rubicon group of five hydro-electric power stations. With a total installed capacity of 26,400 kW., this group has been in operation since 1928, and at present contributes on the average between 130 and 150 million kWh. of electricity per annum to the State system. Power is generated at Sugarloaf during the summer months when water is being released for irrigation, and at other times of the year when storage is full. The four associated mountain stream stations on the Rubicon and Royston Rivers generate maximum power in the winter and spring, when water flow is at its greatest.

Irrigation water will also be utilized at the Hume Weir where a new power station will serve both Victoria and New South Wales. It is being erected by the New South Wales Public Works Department to designs and specifications prepared by the State Electricity Commission of Victoria. Initially, the installed capacity of the power station will be 50,000 kW. Output of electricity, averaging about 200 million kWh a year, will be shared equally by the two States, each contributing its quota of the annual cost. Victoria's share of the electricity generated will be fed into the State system.

§ 4. Queensland.

1. **General.**—(i) *Rainfall.* Particulars of the rainfall pattern of Queensland were given in Official Year Book No. 37, page 1122, and Chapter II.—Physiography, of this issue, contains information on climatic conditions in each State.

(ii) *Administration.* The first comprehensive Water Act in Queensland was the Water Act of 1926 which vested in the Crown the right to the use and flow of all streams, lakes, watercourses, etc., which flowed through or were within the boundaries of two or more occupiers, and also vested in the Commissioner of Irrigation and Water Supply the bed and banks of all boundary streams. The Irrigation Act of 1922 provided for the establishment of Irrigation Areas in approved localities. From 1922 to 1931 the Commissioner of Irrigation and Water Supply administered the Acts, but in 1931 the Land Administration Board was appointed to act as the Commissioner and continued to act until the Irrigation and Water Supply Commission Act of 1946 was proclaimed in 1947. Under this Act the Corporation of the Commissioner of Irrigation and Water Supply was reconstituted. The Commissioner is responsible for carrying out the provisions of the Irrigation Acts 1922 to 1949 and the Water Acts 1926 to 1942. He is also responsible for investigations

into, and the planned development of, water resources of Queensland under the Land and Water Resources Development Acts 1943 to 1946. For particulars of the New South Wales–Queensland Border Rivers Agreement ratified by Acts of both States in 1947 *see* page 1210.

(iii) *Water Utilization in Queensland.* Queensland's predominant interest in the past in the field of water conservation has been the provision of stock and domestic water supplies in its great pastoral areas which contain nearly half the Commonwealth's cattle, a seventh of the sheep and a third of the horses. More than half the State's rural production is derived from cattle and sheep. The cattle are distributed throughout the State, but most thickly between the east coast and the 20-inch average annual isohyet. Sheep are mainly pastured on the inland areas west of this isohyet, whilst dairying is concentrated in the south-eastern quarter of the State. In addition to the stabilization of water supplies in the pastoral areas and the provision of water along stock routes for travelling stock, the development of irrigated pastures on the eastern seaboard for fattening stock adjacent to meatworks and markets has lately received much attention.

The State's agricultural crops differ from those of other States in that a large proportion is tropical. Sugarcane is the greatest individual crop, representing in value some 40 per cent. of total agricultural production. Approximately 12 per cent. of the sugarcane acreage is irrigated and represents some 54 per cent. of the total irrigated area in Queensland. Queensland is Australia's major tobacco-producing State, and plans are in hand to increase annual production of this crop greatly by means of development under irrigation.

2. **Great Artesian Basin.**—(i) *General.* Western Queensland beyond the 22 inch rainfall belt is predominantly pastoral and is mainly dependent for water supplies on artesian and sub-artesian bores, and where surface storage is not readily available, on excavated tanks. The Great Artesian Basin in Queensland corresponds approximately with the area lying west and south of the Great Dividing Range, but excluding the Cloncurry Mineral Field and the Barkly Tableland. It comprises 350,000 square miles of the total State area of 670,500 square miles. Statistics of bores and flow as at 31st December, 1950, are :—Artesian bores drilled, 2,205 ; artesian bores still flowing, 1,490 ; total depth drilled, 3,249,597 feet ; deepest bore, 7,009 feet ; total estimated flow, 217,575,000 gallons per day. Artesian pressure and flow are both steadily diminishing despite new bores drilled. The rate of diminution varies widely throughout the basin. Present general average rates of diminution are :—pressure, 1–2 feet/head, total flow 1½–2 per cent. per annum.

There are some 19,000 miles of bore drains and the greatest length served by one bore is 121 miles. This method of watering is somewhat wasteful, owing to evaporation and soakage, but it is the most economical in first cost. Not more than 5 per cent. of the water is actually used by stock, and present policy is to restrict working flows to serve limited drain systems of smaller dimensions and reduce evaporation and soakage losses. The average loss per mile of drain is 10,000 gallons per day ; with smaller drains this is reduced to 7,000 gallons per day. Pipe lines are very rarely used for distribution owing to high initial cost.

Although artesian beds underlie such a large area of the State, only 87,500 square miles are primarily watered by bore drains. The remaining area is watered by artesian bores (with small or no flow and limited drains), sub-artesian bores, excavated tanks, dams and natural waterholes. In many districts, artesian bores are not economical watering facilities, because of depth, limited area to be watered, and difficult terrain, for distribution of water by drains. High costs have restricted deep drilling. Very few new bores exceed 2,000 feet in depth, and a new bore greater than 3,000 feet in depth is exceptional.

Shallow sub-artesian supplies, of variable quality and volume, are available at depths less than 1,000 feet over a large area of the basin. These beds are not connected with the artesian beds. An essential practical consideration is that the main artesian beds are continuous and the sub-artesian beds are not continuous.

In 1939, a special Committee was appointed to inquire into the geology and hydrology of the Basin and economic use of artesian supplies. A first progress report has been issued by this Committee and its final report is now being prepared. It has been established that the rate of diminution of flow is declining.

In the past, many excavated tanks failed in dry seasons, because of insufficient original depth and capacity, and subsequent silting. Mechanical plant is now almost exclusively in use and much larger tanks are being excavated, even in areas where artesian water may be obtained at a reasonable depth. New tanks with capacities of 20,000 cubic yards and depths of 25 feet are not uncommon. Two tanks with capacities of 65,000 cubic yards each, and depths of 42 feet and 46 feet have recently been completed for watering stock in an area where a good artesian flow may be obtained at a depth less than 2,000 feet.

(ii) *Bore Water Areas.* The Constitution of Bore Water Areas was inaugurated in 1913 to aid pastoral settlement in districts where large flows were available at cost beyond individual capacity and to conserve artesian supplies by fully utilizing the flows from existing bores resumed with the land for closer settlement. Bores and drains are constructed from loan funds repayable over a period of years. The areas are administered by Local Boards or by the Commissioner of Irrigation and Water Supply, acting as a Board. Rates are levied to meet interest, redemption, maintenance and administration costs. Statistics for the year 1950–51 are:—Areas constituted, 65; administered by Commissioner, 53; administered by Local Boards, 12; area benefited, 4,995,931 acres; average rate per acre, 1.12d; number of flowing bores, 59; total flow, 28,441,000 gallons per day; drains served, 2,881 miles.

3. **Stock Route Watering.**—During 1935, a scheme was inaugurated to water adequately stock routes in the western portion of the State including main trunk routes connecting Eromanga to Burketown, Charleville to Normanton, and Clermont to Einasleigh, with branches to railheads, a total distance of 3,117 miles. Watering facilities were also provided on subsidiary routes. Under the Stock Routes and Rural Lands Protection Act of 1944 a co-ordinating board was constituted, representative of Government departments and pastoral interests, under the direction of the Minister for Lands, and with an officer of that Department as superintendent, whose duty was, *inter alia*, to investigate and implement a long-range, co-ordinated plan for adequate watering of all stock routes throughout the State. Natural waters are being supplemented by artificial facilities at intervals of about 9 miles. Construction is supervised by the Irrigation and Water Supply Commission and by local authorities. Completed facilities are vested in local authorities for control and maintenance. From 1935 to 30th June, 1951, 228 facilities had been completed and at 30th June, 1951, 240 facilities were under construction or investigation.

4. **Irrigation.**—(i) *General.* Irrigation as a means of stabilizing and increasing agricultural production is receiving growing attention in Queensland. However, with the exception of the Theodore Irrigation Area, orthodox projects served by a channel system have not so far been developed, though construction of the Clare Irrigation Area on the Burdekin River is well advanced and investigations of several schemes are being carried out. Because of the large variations in both monthly and annual river flows, major developments cannot be undertaken until large storage works are provided. Most irrigation in Queensland is performed by private farmers operating under licence, and obtaining water by pumping from streams or from natural underground storages. Where available, electricity is the most popular source of power for pumping; the principal areas supplied with electricity comprise the Burdekin Delta and the Lockyer Valley.

Furrow irrigation is used for cotton, sugar cane, and most tobacco and some other crops. Spray irrigation is adopted to a considerable extent for fruit, vegetables, fodder crops and a small part of the tobacco. Spraying is well suited to the application of water on deep soils by small pumping plants, particularly when the quantity of water available is limited. Experimental use of the border check method in the irrigation of pasture and fodder crops during the last three years has proved successful and may supersede other methods.

The following table shows for each division of the State the number of irrigators and the areas under irrigated culture for the year ended 31st March, 1951.

AREA OF LAND UNDER IRRIGATED CULTURE : QUEENSLAND, 1950–51.(a)

Division.	No. of Irrigators.	Area under Irrigated Culture (Acres).							
		Vegetables.	Fruit.	Sugar Cane.	Tobacco.	Cotton.	Other Crops.	Pastures.	Total.
Southern Queensland ..	2,564	14,179	1,686	7,150	998	9	10,451	2,713	37,186
Central Queensland ..	208	575	120	..	..	199	1,320	334	2,548
Northern Queensland ..	1,120	2,719	472	37,958	1,971	11	209	76	43,416
Total	3,892	17,473	2,278	45,108	2,969	219	11,980	3,123	83,150

(a) Year ended 31st March, 1951.

The growth of irrigation is illustrated by the following figures for the total area of irrigated land :—1906, 9,922 acres ; 1916, 10,886 acres ; 1926, 24,250 acres ; 1936–37, 44,509 acres ; 1940–41, 60,961 acres ; 1950–51, 83,150 acres.

The pattern of irrigation in Queensland is unlike that in southern States ; the more important developments in tropical and sub-tropical areas are therefore discussed briefly in the sub-sections following. It should be noted that the spring to autumn " irrigation season " of the temperate southern irrigated lands is not applicable, and that round the year irrigation is required throughout most of the State, the timing and duration of the summer " wet " season being too variable to enable a definite non-irrigation season to be fixed.

(ii) *Lockyer Valley.* West of Brisbane and within 50 miles of that metropolitan market is the Lockyer Valley, which is portion of the Brisbane River Basin. The Valley comprises an extensive flood plain where heavy black alluvial soil thickly overlies gravels and sands carrying water suitable for irrigation. Despite a mean rainfall of 30 inches the variation is great, and irrigation is necessary for continuous agricultural production. Surveys suggest that some 60,000 acres of land highly suitable for irrigation are available. Of this area only about 30 per cent. is under irrigation, the number of pumps operating from wells and open water exceeding 550 and 500 respectively. Over 60 per cent. of the farmers operate electric pumps for irrigation purposes and a special policy designed to encourage such development is fostered by the City Electric Light Company which serves the Valley. The Irrigation and Water Supply Commission has constructed a number of small weirs on Lockyer Creek with a total storage of 1,370 acre feet. These also tend to augment and conserve underground supplies. To study local problems, an Irrigation Research Station was established at Gatton in 1946 by the Bureau of Investigation.

The Lockyer Valley produces a substantial proportion of Queensland's onions, potatoes, pumpkins, lucerne, hay, green fodder, maize and dairy products.

(iii) *Burdekin River.* The Burdekin River, which joins the sea between Townsville and Bowen, is a major factor in the life of North Queensland. In most years heavy floods from a catchment twice the size of Tasmania cause extensive damage and traffic disabilities. On the other hand, the fertile Delta Area with its underground water supplies at shallow depth has contributed greatly to the agricultural prosperity of North Queensland. The projected irrigation, hydro-electric and flood mitigation scheme, together with the high level railway bridge at present under construction, will change the Burdekin from a mixed blessing to one of the Commonwealth's greatest resources for agricultural and industrial production. Present development is confined to the Delta Area. The average annual rainfall of this area is some 41 inches, but the major part falls in the months December to March. Consequently, sugar growers and other farmers have tapped the underground water resources of the Delta to obtain supplies in the dry periods.

Sugar is the main irrigated crop, though citrus, pineapples, vegetables and tobacco are also irrigated. The irrigated area is in excess of 30,000 acres, up to 1,000 acre feet of water being drawn daily from underground sources.

In the Home Hill–Inkerman areas on the south side of the Burdekin, water is obtained from shallow wells by electric pumps supplied from a local power station now controlled by the Townsville Regional Electricity Board. Around Ayr, on the north side of the river, electric power from the mains of the Townsville Regional Electricity Board is now being adopted in place of the individual internal combustion engines previously used. At both Home Hill and Ayr water for domestic supply is raised by a windmill on each property.

In 1940 the Burdekin River Trust was formed to safeguard the sugar areas of the Delta from erosion and floods. An Irrigation Research Station has recently been established to study the development of pastures and irrigated crops under local conditions.

A major multi-purpose scheme, involving irrigation, flood control and hydro-electric power generation, is being investigated by the various interested Government Departments under the general supervision of the Burdekin River Authority. The development envisaged would include a dam storing some 4,000,000 acre feet, which would make water available for the irrigation of at least 250,000 acres. The principal industries anticipated are tobacco-growing, dairying and cattle fattening, with sorghum, sunflowers, peanuts, cotton and sugar cane as other possible forms of production.

The recently constituted Clare Irrigation Area is at present being developed for tobacco production. Located from 25 to 37 miles upstream from the mouth of the Burdekin, this area comprises some 6,000 acres which will obtain irrigation water from central pumping stations drawing initially on the unregulated river flow of the Burdekin. This development is a first step in the major Burdekin scheme.

(iv) *Dawson Valley.* The Dawson River, a 392-mile long tributary of the Fitzroy River, rises in the Carnarvon Range and joins the Mackenzie River to form the Fitzroy some 50 miles west of Rockhampton. Lands bordering the river in its northerly course of about 170 miles before its confluence with the Mackenzie River are commonly termed the Dawson Valley. A scheme for the development of the Dawson Valley under irrigation was inaugurated in 1923, providing for the irrigation of some 70,000 acres. Storage for the scheme was to be provided by a dam at Nathan Gorge of some 2,000,000 acre feet capacity. Much investigational and survey work on the scheme was carried out, but the general financial depression and limited loan funds brought about the cessation of this work. However, the initial step in construction had been completed, comprising a weir on the river at Theodore and irrigation works to serve an area of some 3,500 acres supplied from a central pumping station. An additional weir has since been built, giving a total storage of 11,000 acre feet. Pasture, vegetables, cotton, fruit and dairying products are the principal produce. The cheese factory established at Theodore has been closed, but there is a ready market for all cream produced, and with the increase in dairying based on irrigated lucerne and pasture, the future of the area appears assured. Attention has recently been given to the former plans for the Valley and earlier work is now under close scrutiny as a prelude to future development.

(v) *Walsh-Barron Tobacco Lands.* The Walsh and Barron Rivers rise in the Great Dividing Range some 50 to 60 miles south-east of Cairns. Sandy soils suitable for tobacco are to be found in the valleys of these rivers in the neighbourhood of Mareeba and Dimbulah. Surveys indicate that 40,000 acres of land suitable for irrigated agriculture are available, including 32,000 suitable for tobacco. At present some 800 acres of high grade tobacco are grown annually, together with small areas of vegetables and fruit. Six weirs of combined capacity of 1,800 acre feet are being provided on a number of streams to store water for irrigation. Full development of the area is dependent on the provision of a major dam at Nullinga on the Walsh River, and possibly at Tinaroo Falls on the Barron River, and the construction of these dams is being investigated. Tobacco would be the basic crop, whilst peanuts, vegetables, broom-millet, maize, citrus, cotton, and giant cowpeas may prove suitable subsidiary crops. Should pastures be established as a rotational sowing for tobacco, cattle fattening might also be introduced.

(vi) *Border Rivers Project.* The development of the rivers constituting portion of the border between Queensland and New South Wales is under the authority of the Dumaresq-Barwon Border Rivers Commission on which each State is represented. For information on the project *see* page 1210.

5. **Bureau of Investigation.**—Under the Land and Water Resources Development Act of 1943 a Bureau of Investigation has been set up for the co-ordinated investigation of land and water resources development.

The Bureau consists of representatives from the authorities controlling water resources, lands and agriculture, under the chairmanship of the Co-ordinator-General of Public Works. Among notable work carried out by the Bureau of Investigation since its inception has been the trial planting of irrigated pastures with a view to developing mixtures suited to the special conditions of each part of the State. Other valuable work has included the mapping of the ultimate land uses of the State, and the detailed investigation of the agricultural and pastoral potentialities of many regions.

6. **Channel Country.**—Extensive investigations of the Channel Country fed by inland rivers in the south-western corner of the State have been made by the Bureau of Investigation. This country is intersected by shallow and irregular flood channels through which huge volumes of flood waters pass in favourable seasons; consequent on the flooding, a heavy growth of natural pastures is produced on the flooded lands, providing feed in quantities far in excess of that required for the normal stock population of the area. If the occurrence of flooding could be made more reliable by means of storages to create artificial floods, the pastoral resources of the area would be enormous. However, inquiries directed on these lines have revealed that little can be done to increase or stabilize the turn-off of fat cattle by artificial storage, but that improved transport facilities are essential.

At 30th June, 1951, 30 watering facilities, at an estimated cost of approximately £150,000, had been proposed under a Federal-State agreement for stock routes through, and in the approaches to, the Channel Country. Two had been completed, progress in general having been delayed by wet weather and lack of contractors for bore drilling.

7. **Bradfield Scheme.**—Detailed discussion of the scheme proposed by the late Dr. J. J. C. Bradfield for overcoming natural climatic disabilities of the Lake Eyre Basin (South Australia) and Western Queensland will be found on page 1128 of Official Year Book No. 37.

8. **Hydro-electricity.***—Behind the coastal plain of the Cairns–Ingham area is an extensive plateau, the elevation ranging from 2,000 to 3,000 feet, although isolated peaks exceed 4,000 feet. The short coastal streams which rise on the plateau descend rapidly into deep gorges, which they have cut through the old divide. With heavy monsoonal rainfall on their catchments and concentrated fall, these streams represent a considerable potential source of power, but storage, which can in most cases be provided, is essential to control the very variable flow.

The Barron Falls Scheme, 14 miles north-west of Cairns, came into operation in 1935. The installed plant operates under a head of 410 feet and comprises three 2,000 h.p. turbines each connected to a 1,320 kW. generator. Average rainfall varies from 80 to 150 inches along the ranges to less than 35 inches in the western portion of the catchment. There is extreme variation from year to year, resulting in great fluctuation of stream flow which, at Kuranda, has varied from a maximum of 117,000 cusecs in 1911 to a minimum of 30 in 1915. Storage to regulate the flow is possible but has not yet been provided. During periods of low flow the supply of electricity is supplemented by fuel plants at Cairns, Atherton, and Innisfail. Power is distributed over 22,000 volt transmission lines serving the tableland and extending southward along the coast to Tully.

A small hydro-electric scheme on the Mossman River, 5 miles from Mossman, North Queensland, comprises two 120 h.p. turbines operating under a head of 200 feet.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 1184-5.

A hydro-electric power scheme at Tully Falls is to be constructed. Water controlled by Koombooloomba Dam to be built on the upper Tully River will be diverted, a short distance above Tully Falls, through a tunnel and steel penstocks to pelton-driven generators under a head of 1,485 feet. Ultimate installation will be four 18,000 kW. sets, two of which will be installed initially. Future automatic power plants upstream and downstream from Tully Falls will consist of two 7,500 kW. sets under 405 feet head and one 5,400 kW. set under 230 feet head. The combined peak load for the three plants will be 69,000 kW.

Other northern schemes which have been investigated include Freshwater Creek (3,900 kW.); North Johnstone–Russell Rivers (32,000 kW.); Beatrice–North Johnstone Rivers (9,000 kW.); South Johnstone River (25,000 kW.); extension of Barron Falls scheme (22,000 kW.); Herbert River (90,000 kW.). The total potential of the plateau region is therefore about 250,000 kW. at 50 per cent. load factor.

A power plant immediately below the Burdekin Falls Dam of the proposed Burdekin River Irrigation Scheme will operate under an average head of 225 feet. The output of firm power will depend upon the varying demand for water for irrigation, but it is expected to average about 50,000 kW.

South of the Burdekin River no appreciable hydro-electric development is practicable. A plant of 3,200 kW. capacity is being installed to utilize the outflow from Somerset Dam on the Stanley River a few miles above its confluence with the Brisbane River.

§ 5. South Australia.

1. **General.**—(i) *Rainfall.* Brief particulars of the climatic conditions in South Australia were given on page 1129 of Official Year Book No. 37, and Chapter II.—Physiography, of this issue, contains information on the climatic conditions in each State.

(ii) *Administration.* Water supplies, other than irrigation works, are under the control of the Engineering and Water Supply Department, which administers the Waterworks Act governing the supply of water through mains in water districts for townships and farm lands. The Water Conservation Act provides for the construction of storages in non-reticulated areas and authorizes the Minister to "divert and impound the water from any streams or springs or alter their courses, and take water therefrom, or any other waters as may be found in, under or on any land entered upon for the purpose of supplying water to the inhabitants of any water district".

(iii) *Methods of Catchment and Conservation.* Early steps were taken to vest all running streams, springs and "soaks" in the Crown. Since the Water Conservation Act was passed in 1886 more than 550 dams, tanks and "rainsheds" have been built or acquired by the State, in addition to 460 wells and 340 bores, at a total cost of £1,263,752. The rainsheds comprise timber frameworks roofed with galvanized iron to catch precipitation which is delivered to storage tanks. Rainshed catchments vary from a few hundred square feet to four acres, discharging water into tanks ranging in capacity from 2,000 to 500,000 gallons. Over most of the State extraordinary precautions are taken to counteract evaporation. Pipelines in preference to open channels are used to reduce seepage and evaporation. Meters are attached to practically all services to check usage by individual consumers.

2. **Irrigation.**—In South Australia irrigation is almost exclusively confined to the Murray Valley. Except for that held in various lock pools, no water from the Murray is stored in South Australia. Water is either pumped on to the land or gravitated from the river. The upper Murray of South Australia and the Mildura area of Victoria formed the cradle of Australian irrigation. South Australian irrigation commenced with an agreement between the Government and the Chaffey Brothers in 1887 whereby 250,000 acres at Renmark were made available for irrigation settlement. Including land allotted for War Service Land Settlement purposes, the Department of Lands administers an area of 31,007 acres of irrigable high land, together with 9,381 acres of reclaimed swamp and 167,042 acres of non-irrigable land in the irrigation areas and 34,147 acres of land temporarily leased and reserved for commonage or other purposes, amounting in all to 241,577 acres. In addition, the Renmark Irrigation Trust controls 20,557 acres, of which more than 8,500 are irrigated. Water used for irrigation purposes in 1950–51 in the high land

irrigation areas controlled by the Department of Lands was approximately 90,000 acre feet, in addition to which approximately 60,000 acre feet were used on reclaimed areas by gravitational watering. In the Renmark area water used for irrigation in 1950–51 was 26,300 acre feet. The production of the upper Murray areas is almost exclusively fruit and vines. Principal crops are sultanas, currants, lexias, apricots, peaches, nectarines, pears and figs (mainly for dried fruit), wine grapes and citrus fruits. Before irrigation, these semi-arid lands were of little productive value. The following tables show the acreage devoted to various crops in the government controlled and Renmark Irrigation Trust areas on the upper Murray, and in the government controlled reclaimed swamp districts near the mouth of the Murray which are devoted to dairying.

IRRIGATION AREAS ADMINISTERED BY DEPARTMENT OF LANDS AND RENMARK IRRIGATION TRUST, SOUTH AUSTRALIA: AREA OF LAND UNDER IRRIGATED CULTURE, 1950–51.

(Acres.)

Area.	Vine Fruits.	Tree Fruits.	Citrus Fruits.	Lucerne.	Other Fodders.	Total.
Orchard land—						
Berri	5,569	707	1,102	29	..	7,407
Cadell	583	112	92	39	..	826
Waikerie	2,067	402	1,052	23	..	3,544
Cobdogla	3,955	110	166	18	..	4,249
Moorook	414	115	165	17	..	711
Kingston	283	78	180	1	..	542
Mypolonga ..	27	329	459	1	..	816
Chaffey	812	33	8	1	..	854
Total ..	13,710	1,886	3,224	129	..	18,949
War Service Land Settlement—						
Coolton	265	130	392	..	..	787
Loxton	1,290	287	878	..	..	2,455
Loveday ..	237	46	21	..	..	304
Grand Total ..	15,502	2,349	4,515	129	..	22,495
Renmark Irrigation Trust	7,250	620	845	..	..	8,715
Reclaimed Swamp Land—						
Monteith ..	..	..	..	..	933	933
Mypolonga ..	..	..	..	40	1,362	1,402
Wall	..	..	..	9	352	361
Burdett	..	..	..	1	106	107
Mobilong	..	..	..	45	376	421
Long Flat ..	..	..	..	..	393	393
Neeta	..	..	..	..	596	596
Pompoota ..	..	..	..	3	417	420
Cowirra	..	..	..	24	537	561
Jervois	..	..	..	38	3,613	3,651
Total ..	..	..	..	160	8,685	8,845

The expenditure incurred by the Government to the 30th June, 1951 in purchase of land, reclamation of swamps, preparation of irrigable lands for fruit growing, and purchase of pumping plants for drainage and water supply is approximately £4,928,000. Further irrigation development is being undertaken as a part of the Commonwealth-wide War Service Land Settlement Scheme. South Australia's share of a total of 32,000 acres of horticultural plantings under the Scheme is 10,000 acres, comprising citrus 3,500 acres, vines 5,300 acres, and deciduous tree fruits 1,200 acres. Schemes already approved and under construction will absorb between 7,000 and 8,000 acres, and further areas are being selected to take up the balance. Holdings will be provided for about 380 settlers, and annual production from the 10,000 acres of plantings mentioned is estimated at:—Citrus, 1,000,000 cases; deciduous tree fruits—dried, 800 tons, fresh, 2,300 tons; dried vine fruits, 5,600 tons; wine grapes, 12,800 tons. On present-day prices, the value of this production would approximate £1,500,000.

Renmark Irrigation Trust is administered by a local board of management consisting of seven members. This area differs from other South Australian irrigation areas in that the land is freehold instead of leasehold, self-contained and self-controlled. Every settler is entitled to vote for the election of Trust members. The Trust maintains 80 miles of channel for the reticulation of 8,715 acres.

3. **Country Water Supply Schemes.**—(i) *Summary.* Water conservation and distribution works in South Australia have cost £24,458,000 (exclusive of river control and irrigation works on the River Murray which are dealt with above). A summary of statistical information concerning country supplies in 1949–50 follows:—Length of water mains, 5,489 miles; capacity of storages, 9,500 million gallons; approximate population served, 237,000; area served, approximately 4,000,000 acres; and total capital cost, £17,410,000.

Areas extending for a distance of 90 miles north of Adelaide are supplied from the Warren and Barossa Reservoirs in the Barossa Ranges, and agricultural towns and areas further north are supplied from Beetaloo, Bundaleer and Baroota Reservoirs, with a connexion to the Warren system. Eyre Peninsula has, up to the present, been supplied from the Tod River Reservoir (9,167 acre feet) and three small reservoirs near the Franklin Harbour District, but demands have increased to such an extent in recent years that further sources of supply are necessary, and with this end in view a water-bearing area known as the Uley-Wanilla Basin has been developed, and water from it is now being used in the Tod River system.

(ii) *Morgan-Whyalla Water Supply Scheme.* For particulars of the construction and works of the 223-mile pipe line bringing water from the Murray at Morgan to Whyalla on Spencer Gulf *see* Official Year Book No. 37, page 1132. The Morgan–Whyalla Water Supply Scheme forms part of the South Australian Country Water Supply system referred to above.

4. **Underground Water.**—The occupied portion of South Australia is, on the whole, well endowed with underground water. The extent of the several artesian basins is tolerably well known. There are also considerable areas, notably in the south-east of the State, in which ground water occurs. Quality varies widely, but a great deal is at least useful for watering stock, the major use to which it is put. Apart from numerous boreholes and wells tapping underground water for farms, stations and towns, two notable basins are being developed on Eyre Peninsula—one at Flinders (Streaky Bay) and the other at Uley-Wanilla, near Port Lincoln. Leigh Creek coalfield, some 350 miles north of Adelaide, derives its supply from a borehole at Sliding Rock mine, the water being pumped through a pipeline 25 miles long.

The deepest portion of the Great Artesian Basin (in the north-east) is not extensively developed because development costs are large in proportion to the carrying capacity of the arid land. Deep boreholes have been drilled by the Government, however, to provide watering places along stock routes, and pastoralists rely largely on supplies in suspended basins at shallower depths.

The use of the waters of the Murray Basin is essential to settlement in the Murray Mallee country and in the south-east, especially for farms, but also for township supplies for Mount Gambier, Naracoorte, Bordertown and Pinnaroo. The maximum depth of boreholes is 235 feet and the minimum 71 feet. Average tested yield is 14,808 gallons per day.

Pastoralists, farmers, market gardeners and others have been assisted with expert advice on drilling, for which the Government maintains about 40 drills. A large area within the Murray River Basin has been examined critically to ascertain the extent of land which could be used for lucerne, and an examination of a large part of Kangaroo Island and Southern Eyre Peninsula has been completed in connexion with Soldier Settlement schemes. Examination of large areas in the Upper South-East has been undertaken in connexion with land development schemes.

The results of comprehensive surveys of underground supplies undertaken by geologists of the South Australian Government have been published in the State's geological survey bulletins in recent years.

5. **Farm Water Schemes.**—While the Department of Mines and the Engineering and Water Supply Department give assistance to individual farmers in the provision of supplies from underground sources, a great part of the farming areas derive water supply under pressure from the extensive distribution systems connected to various reservoirs or the Murray River.

6. **South-Eastern Drainage.**—For some information on the drainage schemes necessary for the disposal of surplus water in areas in the south-east of South Australia *see* Official Year Book No. 37, page 1133.

§ 6. Western Australia.

1. **General.**—(i) *Rainfall.* Brief particulars of the climatic conditions in Western Australia were given on page 1133 of Official Year Book No. 37, and Chapter II.—Physiography, of this issue, contains information on the climatic conditions in each State.

(ii) *Administration.* Irrigation districts are administered under the Rights in Water and Irrigation Act of 1914–1945 and the Government is advised by an Irrigation Commission representing the local irrigationists and government technical and financial branches. The Goldfields Water Supply is administered by a branch of the Public Works Water Supply Department and its responsibilities include control of water from this scheme for agricultural purposes. The metropolitan water supply is controlled by a separate department under the control of the Minister for Water Supply, Sewerage and Drainage. Under the Water Boards Act (1904) fourteen towns are administered by local water boards and 30 are under direct Ministerial control. The Minister also controls three District Farming Schemes. Water rights over water flowing in streams and water courses is vested in the Crown unless specifically appropriated for irrigation purposes under the irrigation legislation.

2. **Irrigation.**—The main irrigation districts—Harvey, Waroona and Collie—are along the south-west railway line between Waroona (70 miles from Perth) and Dardanup (116 miles from Perth). The total area irrigated in these districts during 1950–51 was 18,923 acres and the total water used was 56,870 acre-feet. The total acre waterings (i.e. the number of acres watered multiplied by the average number of waterings) was 85,440.

Harvey Districts (Nos. 1 and 2—32,663 acres) are supplied from the Harvey Weir (8,300 acre-feet) and Stirling Dam (44,344 acre-feet), Waroona District (10,325 acres) from Drakesbrook Dam (1,855 acre-feet) and Samson's Brook Dam (6,540 acre-feet), and Collie District (28,762 acres) from Wellington Dam (27,800 acre-feet).

The following table, which shows acre waterings supplied to crops in the irrigation districts of Harvey, Waroona and Collie during the seasons 1938–39 and 1946–47 to 1950–51, illustrates the growth of these irrigation schemes.

IRRIGATION, WESTERN AUSTRALIA: ACRE WATERINGS.

Year.	Pasture.	Fodder.	Potatoes.	Vegetables.	Orchard.	Flax and Broom Millet, etc.	All Crops.
1938–39	31,049	934	3,142	692	922	..	36,739
1946–47	61,948	547	4,304	3,209	1,096	..	71,104
1947–48	57,450	508	3,714	3,433	1,190	..	66,295
1948–49	71,687	640	2,692	3,562	1,448	..	80,029
1949–50	79,373	685	4,591	4,297	1,369	4	90,319
1950–51	76,431	793	2,946	4,090	1,180	..	85,440

3. Water Supply Schemes.—(i) *Goldfields Scheme.* Western Australia has one of Australia's most spectacular water supply schemes, and a brief account of its development will be found on page 1134 of Official Year Book No. 37, and an account in greater detail on page 576 of No. 6. Mundaring reservoir on the Helena River, 26 miles from Perth, is the source of water supplied to the goldfields, and has a capacity of 15,100 million gallons and a catchment of 569 square miles. The water now passes through 346 miles of steel main, mostly of 30 inch diameter, aided by eight pumping stations, involving a total net lift of 1,280 feet.

Hundreds of miles of branch mains and pipes have been laid to mining districts, towns and farming districts, the most important being the Norseman extension of 101 miles. The system serves 34 towns and water is reticulated to 970,000 acres of farming lands. Total length of mains is 1,793 miles and the population served is 55,000. Total quantity of water pumped from Mundaring in 1950–51 was 2,470 million gallons. Total cost of system to the end of 1950–51 was £7,331,691.

Work has now been completed on raising the impounding wall at Mundaring Weir and preparations are well in hand for the raising of the wall at Wellington Dam (50 feet). Steady progress has been made on the 30 inch diameter pipeline from Wellington Dam to Narrogin, approximately 30 miles having already been completed. Large storage reservoirs have been constructed at Kalgoorlie (25 million gallons) and at No. 8 Pumping Station (12 million gallons) for the purpose of safeguarding supply during the hot summer months. To increase the quantity of water delivered from No. 3 Pumping Station to No. 4 Pumping Station and the Goldfields Area, a booster pump hasnow been installed near Kellerberrin. This pump, which came into operation during 1950–51, is capable of giving an additional flow through the main conduit of approximately one and a half million gallons per day.

(ii) *Rock Catchments.* An interesting feature of the State's conservation system is found in the Barbalin, Narembeen and Kondinin District Farming Land Schemes in the wheat belt, where extensive granite outcrops have been used as catchments. The rain is caught at the foot of the rocks, and pumped to tanks from which the water is reticulated to farms and to a number of small towns. For further particulars *see* Official Year Book No. 37, page 1135.

(iii) *South-west Scheme.* The Commonwealth Government has agreed to assist a scheme to extend water for agricultural areas and towns in the south-west of Western Australia, which will be administered by the State Government. It is estimated that the scheme will cost £4,300,000 of which the Commonwealth will contribute £2,150,000. The scheme provides for raising the height of the Mundaring Weir and the Wellington Dam to increase the storage capacity of these reservoirs to 15,000 million gallons and 38,000 million gallons respectively (*see* above), and for increasing the capacity of pumping stations on the Goldfields pipeline to permit water diversions from that source. Twenty-three towns and over 4,000,000 acres of agricultural country will benefit.

4. Underground Water.—Individual farmers, orchardists, market gardeners and others derive water from wells or windmills wherever available, and, where power is available, pumps and motors are used to tap such supplies. The Department of Public

Works has twelve boring plants which are lent out to farmers to facilitate boring operations to an average depth of 150 feet. The Department also contracts with private firms to bore for communal farm supplies. During the past 58 years 300 artesian and sub-artesian bores have been sunk, mostly for private purposes. The total depth of all recorded bores in Western Australia is 245,604 feet; daily flow is 87,692,500 gallons; and the average depth at which water is struck is 819 feet. Maximum depth of any bore is 4,006 feet and minimum 21 feet.

5. **Ord River Scheme.**—The Ord River in the north-west of Western Australia traverses a tropical area served with monsoonal rains of irregular incidence and quantity, varying from 20 inches in the south to 30 in the north. The hottest months (December to March) are also months of highest rainfall. Communications and population are sparse. The Western Australian Government is considering a proposal to build a dam to conserve 2,000,000 acre feet of water, equipped with hydro-electric plant, which might supply irrigation water for an area of 100,000 acres, if investigations show that the climate and soil conditions are suitable for vegetables, tropical fruits and rice. However, the economic production of these and other crops, as well as the possible use of such irrigation areas for interim fattening of cattle, is being examined at the Kimberley Research Station on the Ord River.

§ 7. Tasmania.

1. **General.**—(i) *Rainfall.* Brief particulars of the rainfall pattern in Tasmania were given on page 1136 of Official Year Book No. 37, and Chapter II.—Physiography, of this issue, contains information on the climatic condition in each State.

(ii) *Main Purposes of Conservation and Utilization.* Owing to its fortunate rainfall position, scarcity of water is not a serious problem in normal seasons. Conservation of water for hydro-electric generation is the predominant interest, and conservation for domestic and industrial purposes is more important than irrigation. Conservation of water on farms is not practised to the same extent as on the mainland, probably because running streams and good rainfall are on a more generous scale. Provision of artificial storages (apart from house tanks) is rare, but progressive landowners are beginning to take advantage of modern plant, such as bulldozers, to provide small excavated storages in their properties. Underground water is of poor quality and a small quantity exists over an area in the Midlands which has been exploited to a limited extent only by bores and windmills. Geological conditions do not appear to favour the utilization of ground water except on a minor scale. There is only one known flowing bore—at Spreyton, which yields 1,690 gallons per hour.

(iii) *Administration.* The State does not own all natural waters as in Victoria, and consequently the subject of water rights is a difficult one. The Mines Department has power to grant certain rights for mining operations, and the Hydro-Electric Commission must approve the abstraction of water from any stream or lake of potential value for power generation. There is no machinery other than the Courts for deciding the issue in cases where municipal councils or private individuals propose to divert water for town supplies or irrigation from streams in which neither of these two authorities is interested. The only exceptions are a few municipal and industrial undertakings which have statutory rights.

2. **Hydro-electricity.***—Tasmania depends entirely on water for power development, and its power potential has been estimated at 3,500,000 h.p. on the basis of 50 per cent. load factor and 80 per cent. turbine and generator efficiency. The Hydro-Electric Commission, the authority controlling the generation of electricity in Tasmania, provides most of Tasmania's power requirements from four power stations—Waddamana, Tarraleah, Shannon and Duck Reach. The Mount Lyell Mining and Railway Co. Ltd.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 1193-5.

also operates a 10,000 kW. plant at Lake Margaret on the west coast to serve copper mines, and this station is interconnected with the Commission's network. Small stations operated by tin mining companies have a total capacity of 2,000 kW.

Only a brief description of the major schemes is given below.

The first stage of the Waddamana power station with an installed capacity of 10,000 h.p., was completed in 1916. This station which is now called Waddemana A power station has subsequently been extended to 66,000 h.p., while a new station Waddemana B, of capacity 66,800 h.p., was completed in 1947–48.

In the Shannon scheme water from the Great Lake passes down the Shannon River by pipeline and canal to the Shannon Power Station, where 14,500 h.p. is generated before the water passes into the Waddamana canal and power station.

The Waddamana and Shannon power stations are fed with water from the Great Lake, which is situated near the geographical centre of the State at an elevation of 3,380 feet above sea level.

Tarraleah power station is situated on the Nive River, but is served by water from the River Derwent and Lake St. Clair. The water from Lake St. Clair flows down the Derwent to Butler's Gorge, where a 200 feet high concrete dam (Clark Dam) impounds up to 243,000 acre feet of water.

The Butler's Gorge power station is situated at the foot of the Dam and at maximum water level it can develop 17,100 h.p. Water discharged from Clark Dam is diverted into the Tarraleah Canal and thence into Tarraleah Lagoon for use in the Tarraleah power station which has a capacity of 126,000 h.p.

Work has commenced on the Tungatinah Power Development which will regulate the run-off from that part of the Central Plateau which lies between the Great Lake and Lake St. Clair catchments. A dam will divert the headwaters of the Nive River into a chain of lakes formed by constructing levees across the outlets of Woodward's, Brady's, Big and Nive Marshes. Water will then be conveyed by a tunnel and penstocks to the Tungatinah power station which will have an ultimate capacity of 175,000 h.p. As a further stage of this project a dam across the River Dee at the outlet from Lake Echo will provide about 300 cusec-years of storage which will be used to augment the storage in Brady's, Big and Nive Marshes.

The Trevallyn Power Development is being undertaken primarily to meet the power requirements of the aluminium industry. It involves the construction of a power station at sea level and works to bring water from the Second Basin in the South Esk River to the Tamar, about two miles from Launceston. To increase the storage capacity and regulate the flow of the Lake River, weirs will be constructed at its outlet from Arthur and Woods Lakes.

The following table shows the development of Tasmania's hydro-electric power resources at the end of 1950 :—

HYDRO-ELECTRIC POWER RESOURCES : TASMANIA.

Power Station.	Installed Capacity.	Ultimate Capacity.
	H.P.	H.P.
Waddamana A and B	132,800	132,800
Shannon	14,500	14,500
Tarraleah	105,000	126,000
Butler's Gorge	Nil	17,100
Duck Reach	2,600	2,600
Trevallyn	Nil	112,000
Tungatinah	Nil	175,000
Lake Margaret	13,800	13,800

3. **Industrial.**—Three principal industrial schemes have been installed privately. The Australian Newsprint Mills pump approximately 6,000,000 gallons a day from the Derwent River at Lawitta for the Boyer mills. Associated Pulp and Paper Mills pump several million gallons a day from Emu River at Burnie, and Titan Products Pty. Ltd. reticulate water from Chasm Creek to their factory at Weybridge. Potential sources capable of greater development without storage exist on the Derwent, South Esk, Huon, Lake, Mersey and Forth Rivers. There is also a great reserve of untapped permanent streams in the western half of the State, at present largely unsettled. Diversion to the eastern side of the watersheds is not regarded as practicable.

4. **Irrigation.**—There are no State irrigation projects, but preliminary inquiries as to the possibility of establishing one in the Coal River Valley are to be made. All systems operating are privately owned and, with one exception (at Bushy Park), are single-farm units. At Bush Park a small system serves a group of properties. The larger proportion of the area under irrigation is watered by gravitational systems and the remainder comprises areas devoted to vegetables and served by municipal water supplies. Irrigation, as practised in Tasmania, was applied in 1950–51 to 7,242 acres devoted to: hops (1,075 acres); fruit (981 acres); pastures (4,700 acres); green fodder, etc. (167 acres) and other crops (319 acres).

§ 8. Northern Territory.

1. **Climate and Topography.**—Some particulars of the climate and main topographical features of the Northern Territory were given on page 1138 of Official Year Book No. 37, and in this issue information on climatic conditions will be found in Chapter II.—Physiography, and a brief outline of contour and physical characteristics in Chapter X.—The Territories of Australia.

2. **Administration.**—Under the Control of Waters Ordinance (1938) of the Northern Territory natural waters are vested in the Crown. Where a watercourse or lake forms a boundary of any land alienated by the Crown, the beds and banks are deemed to remain the property of the Crown (except in special cases) and diversion of water is prohibited except under conditions prescribed.

3. **Underground Water.**—Artesian water is found mainly in the south-east where the Great Artesian Basin enters the Territory. Pastoral (beef) production accounts for the bulk of the Territory's income, and the marked seasonal conditions affect the industry's economy. During the wet summer season there is adequate water, but during the winter most natural watering points disappear, and pastures dry. Bores supplement the permanent watering points, which are mainly along river frontages. The cattle industry is concentrated in the area in which the feed retains an appreciable nutritive value during the winter despite the dry conditions. This area is not in the wetter coastal regions, but in the inland belt of 15 to 25 inch rainfall and to the north of Alice Springs. Lack of bores is a limiting factor in the industry's economy, as cattle are able to thrive only within certain distances of reliable water.

Some 600 bores have been recorded, but complete records are not available. Maximum depth is more than 600 feet. For further information *see* Official Year Book No. 37, p. 1139.

4. **Irrigation.**—There are no large-scale water conservation projects in the Territory with the exception of the Manton Dam (80,350 acre feet) which serves Darwin with a reticulated supply. Irrigation has therefore assumed no current importance. For particulars of present activity and potentialities *see* p. 1138 of the previous issue.

§ 9. Papua and New Guinea.

1. **Rainfall.**—When all localities (32 stations) where gauges are kept are taken into consideration, the average annual rainfall over periods varying from two to ten years is about 159.21 inches. This figure includes both inland and coastal stations.

2. **General.**—For a general description of these territories *see* Chapter X.—The Territories of Australia, pp. 346, 349–350 and 360–362 of this Year Book. Irrigation has not been developed on any organized basis owing to the availability of high rainfall and the nature of agricultural development. The main water conservation interest in New Guinea at present is the hydro-electric potential.

Those portions of New Guinea administered by Australia are well served with large rivers deriving their water from heavy tropical rains and high mountains which rise to 13,000 feet. Complete data concerning water resources are not available, but it is known that the opportunities for production of hydro-electric power are extensive. Some authorities estimate that 20,000,000 h.p. could be generated. Present investigations have been limited to those areas where a demand for power is likely to arise. New Guinea has a substantial native population and few major industries.

Explorations over the southern portion, known as Papua, have resulted in the collection of much information concerning water resources. The largest stream is the Fly River, at least 500 miles long, which is situated in the western division. Its large tributaries extend to the northern boundary of the Territory rising among lofty mountain ranges. Records show that at a point above the tidal influence, where the river is 600 yards wide and 40 feet deep, the stream travels at a rate of 3½ miles per hour and discharges 105,200,000 gallons per minute. All the principal rivers flow from the main range in a southerly direction. Most of them carry a large volume from a great height over relatively short distances. They have a total catchment of about 50,000 square miles having an elevation between 2,000 and 13,000 feet. The Government Geologist has estimated that if only 50 per cent. of the annual rainfall were utilized through a height of only 500 feet a total of 8,500,000 h.p. would be produced.