

CHAPTER XXIII.

WATER CONSERVATION AND IRRIGATION.

§1. Artesian Water.

1. **General.**—In every country in which droughts are recurrent, there are few problems the solution of which is of greater importance than that of an adequate system of water conservation. Much has been done in Australia so far as the supply of water to centres of population is concerned, and a description of several of the metropolitan water-works will be found in the chapter dealing with Local Government. Interstate Conferences on artesian water were held in 1912, 1914, 1921, 1924, and 1928, when combined Governmental action was agreed upon with reference to delimitation of the artesian basins, hydrographic surveys, reason for decrease in flow, analyses and utilization of artesian water, etc. (See map on page 649.)

2. **The Great Australian Artesian Basin.**—In speaking of the "Great Australian Artesian Basin," the area is understood which includes (a) considerably more than one-half of Queensland, taking in practically all that State lying west of the Great Dividing Range, with the exception of an area in the north-west contiguous to the Northern Territory; (b) a considerable strip of New South Wales along its northern boundary and west of the Great Dividing Range; and (c) the north-eastern part of South Australia proper, together with the extreme south-eastern corner of the Northern Territory. This basin (shown approximately by the map on page 649) is said to be the largest yet discovered, and measures about 600,000 square miles, of which 376,000 square miles are in Queensland, 118,000 square miles in South Australia, 80,000 square miles in New South Wales, and 25,000 square miles in the Northern Territory. The area of the intake beds is estimated at 60,010 square miles, viz., 50,000 square miles in Queensland and 10,010 square miles in New South Wales. A description of the basin and its geological formation will be found in previous issues of the Year Book (see No. 6, p. 569).

3. **The Western Australian Basins.**—The Western Australian Basins fall naturally within five distinct groups, viz., the Eucla Basin, in the extreme south-east of the State, extending well into South Australia along the shores of the Great Australian Bight; the Coastal Plain Basin, west of the Darling Range; the North-West Basin, between the Murchison and Ashburton Rivers; the Gulf Basin, between Cambridge Gulf and Queen's Channel; and the Desert Basin, between the De Grey and Fitzroy Rivers.

The Recent and Tertiary strata which enter Western Australia at its eastern border, and which have a prevailing dip towards the Great Australian Bight, form the Eucla artesian water area. Where boring operations have been undertaken, the water has been found to be salt or brackish, and there are other conditions affecting the supply, such as local variations in the thickness of the beds, their relative porosity, and the unevenness of the floor upon which they rest, which, so far, have not been examined with sufficient thoroughness to enable many particulars to be given in regard to this basin.

In the Coastal Plain Basin to the west of the Darling Ranges artesian boring has, on the other hand, been carried on successfully for many years.

4. **The Murray River Basin.**—The Murray River basin extends over south-western New South Wales, north-western Victoria, and south-eastern South Australia. It is bounded on the west by the azoic and palaeozoic rocks of the Mount Lofty and other ranges extending northwards from near the mouth of the Murray to the Barrier Range, and on the east and north-east by the ranges of Victoria and New South Wales. This tertiary water-basin is occupied by a succession of sedimentary formations, both porous and impervious. It is of interest to note that the waters of the Murray River are partly

supplied by influx from the water-bearing beds of this basin; this is proved by the fact that, at low water, springs are observed at certain places flowing into it from beneath the limestone cliffs from Pyap Bend downwards. Similar springs exist along the courses of other branches of the River Murray system, where they cut through the tertiary formation. On the Victorian side bores have been put down, and water has been struck at various levels.

5. **Plutonic or Meteoric Waters.**—In previous Year Books will be found a statement of the theory of Professor Gregory* as to the origin of the water in the Australian artesian basins, together with the objections held thereto by a former Government Geologist of New South Wales † (See Official Year Book No. 6, p. 570).

6. **Artesian and Sub-Artesian Bores.**—(i) *General.* The following table gives particulars of artesian and sub-artesian bores in each State and in the Northern Territory:—

ARTESIAN AND SUB-ARTESIAN BORES, 1928–29.

Particulars.	N.S.W.	Vic.	Q'land.	S. Aust. (c)	W. Aust.	N. Ter.	Total.
Bores existing .. No.	560	380	19,247	155	242	191	4,775
Total depth of existing bores feet	923,764	101,200	44,119,350	114,727	223,389	62,375	5,544,805
Daily flow 1,000 gals.	277,043	(b)	2304,812	212,971	70,112	7,723	2472,661
Depth at which artesian water was struck—							
Maximum .. feet	4,338	800	7,009	4,850	3,925	1,760	7,009
Minimum .. feet	89	150	10	55	39	42	10
Temperature of flow—							
Maximum .. °Fahr.	139	(b)	212	268	140	(b)	212
Minimum .. °Fahr.	68	(b)	78	82	75	(b)	68

(a) Flowing bores only. (b) Not available. (c) Government bores only. (d) Total depth of all bores. (e) Incomplete. (f) Not including 1,440 bores in course of construction, abandoned, or uncertain.

7. **Details for States.**—Considerations of space preclude the insertion of separate particulars of operations in the States during the year 1928–29. Details for earlier years will, however, be found in previous issues of the Official Year Book.

§ 2. Irrigation.

1. **General.**—Australia's first experiments in irrigation were made with the object of bringing under cultivation areas in which an inadequate rainfall rendered agricultural and even pastoral occupations precarious and intermittent, and, although these original settlements have generally proved fairly successful, most of the States, instead of promoting new settlement in unoccupied regions, are adopting the policy of making existing settlements closer, by repurchasing large estates, subdividing them into holdings of suitable sizes for cultivation, and selling the land upon easy terms of payment. It is in connexion with this Closer Settlement policy that the special value of irrigation is recognized.

2. **New South Wales.**—(i) *General.* The recognition of the fact that the area suitable for cultivation might be extended largely by a system of water conservation and irrigation has induced the Government to undertake various detached works and schemes, which will constitute portion of the system necessary to serve the whole State.

* See J. W. Gregory, F.R.S., D.Sc.: "The Dead Heart of Australia," London, John Murray, 1906; and "The Flowing Wells of Central Australia," Geogr. Journ., July and August, 1911.

† E. F. Pittman, A.R.S.M., formerly Government Geologist of New South Wales: "Problems of the Artesian Water Supply of Australia, with special reference to Professor Gregory's Theory." (Clarke Memorial Lecture, delivered before the Royal Society of New South Wales, 31st October, 1907); "The Great Australian Artesian Basin," Sydney, 1914; and "The Composition and Porosity of the Intake Beds of the Great Australian Artesian Basin," Sydney, 1915.

The system, and the works necessary to its maintenance and development within the State of New South Wales, are under the control of the Water Conservation and Irrigation Commission, which consists of the Minister for Agriculture for the time being as Chairman, and two other Commissioners. The works controlled by the Commission include the great Murrumbidgee Irrigation Scheme; the smaller irrigation settlements at Hay, Curlwaa (Wentworth) and Coomealla; national works of water conservation; shallow boring for settlers; and water trusts and artesian bore trusts operating under the Water Act of 1912. The Commission has control also of storage and diversions of water by private persons for purposes of conservation and irrigation.

(ii) *Murrumbidgee Irrigation Scheme.* The main features of the scheme include a storage dam across the Murrumbidgee at Burrinjuck to retain the river flow, which is released for use lower down the river particularly during the dry summer months; a movable diversion weir at Berembé, about 240 miles below the dam, to turn the required amount of water from the river into the main canal; a main canal, leaving the river near the weir; four main branch canals and a series of subsidiary canals and distributing channels through the area to be irrigated; bridges, checks, regulators and other structures throughout the entire system, and meters for measuring the volume allowed to each farm. Towns and villages, roadways to serve each farm, and a general surface drainage system, are also included in this scheme.

Further details in respect of the storage dam, diversion weir and canals, together with the areas thrown open for settlement are contained in previous issues of the Official Year Book. (See Official Year Book No. 15, page 442).

Particulars in respect of tenure are set out in Chapter V., Land Tenure and Settlement.

The irrigation area is situated on the northern side of the Murrumbidgee River, where it is anticipated that there will ultimately be upwards of 200,000 acres under irrigation in blocks devoted to fruit, vegetable and rice growing, dairying, stock raising, etc. With the aid of irrigation, the soil and climate of these areas are suitable for the production of apricots, peaches, nectarines, prunes, pears, plums, almonds, melons, cantaloups, and citrus fruits, also wine and table grapes, raisins, sultanas, figs, olives, and most varieties of vegetable and fodder crops. Dairying and pig-raising are being undertaken by a large number of settlers in the areas, and the canning and drying of fruit and the production of wine are industries of considerable dimensions. The district is one of the greatest fresh fruit producing centres in the State. The growing of rice on this area is an important industry. Rice from an area of about 14,000 acres was harvested in 1929, the resultant crop being approximately 24,000 tons, which is sufficient for the whole of the requirements of the Commonwealth. Approximately 19,000 acres will be sown to rice for the 1929-30 season giving an estimated yield of 30,000 tons of paddy rice.

On the 30th June, 1929, 1,814 farms were held under permanent tenure, representing a total area of 120,860 acres. In addition, there were 91 farms comprising a total area of approximately 38,834 acres occupied under permissive occupancy pending the granting of permanent titles. The number of town blocks held was 932.

In the matter of cultivation, the following particulars indicate the extent of the work performed by the settlers:—There are approximately 7,612 acres under deciduous fruits, 5,355 under citrus fruits, 5,666 under vines, and for the 1930 harvest about 19,000 acres under rice. The estimated population of the area is about 15,000.

The total production of the Murrumbidgee Irrigation areas for the year ended 30th June, 1929, is valued at £970,000.

(iii) *Curlwaa Irrigation Area.* The Curlwaa irrigation area is situated on the Murray River near its junction with the Darling River, and comprises 10,550 acres, of which on 30th June, 1929, irrigable holdings consisting of 2,161 acres had been taken up in areas of 1½ to 40 acres, with a leasehold tenure of 30 years, at rentals of from 3s. to 10s. per

acre per annum for the most part, and up to 35s. per acre in some blocks set apart during recent years. Of the balance, 7,011 acres were leased as non-irrigable holdings for short terms, in the majority of cases up to five years, with rentals of from 5d. to 5s. per acre, while the remainder of the area, with the exception of a few vacant holdings, is made up of roads, channels, and other reserves. Of the irrigable area, 1,296 acres are planted as orchards and vineyards, of which 1,163 acres are in full bearing. There is also a small area under lucerne. It has been proved that the Curlwaa soil is eminently suited to the growth of citrus and other kinds of fruit, and some of the finest oranges grown in New South Wales are produced on this area.

The estimated weight of dried fruits produced on the Curlwaa area in the year 1928-29 was 908 tons, while the production of citrus fruit was 22,684 cases. The total value of production for the year is estimated approximately as follows:—Dried fruits, £50,974; citrus fruits, £15,311; other fresh fruit, £677; other produce and live stock, etc., £5,000; a total of £71,962. The production of citrus was considerably below normal, the crop having been seriously affected by the severe frost of the latter part of the year 1927.

Water is pumped from the Murray River by a suction gas plant in 3 units, with a total capacity of 11,000 gallons per minute and a lift of about 36 feet, and is supplied to the lessees at a flat rate of 20s. per acre per annum. There is also a general rate of 14s. per acre per annum upon the portion of the irrigated area in productive bearing. During the season 1928-29 the quantity of water supplied was 274,471,560 cubic feet, or 6,301 acre-feet, the average area watered during six irrigations being 1,700 acres. Each lessee is entitled to receive a quantity of water equivalent to a depth of 30 inches per annum.

(iv) *Hay Irrigation Area.* The Hay irrigation area consists of about 4,500 acres, of which on 30th June, 1929, the area held and used for irrigation purposes was 1,027 acres, in 107 blocks of from 3 to 30 acres. The term of lease is generally 30 years, and the annual rental from 5s. to 12s. per acre. In addition, there was at that date an area of 2,886 acres of non-irrigated land taken up in 53 blocks for short terms up to five years, with rentals of from 1s. to 10s. per acre. Water is lifted from the Murrumbidgee River by suction gas-driven pumping machinery in 2 units, with a total capacity of 4,000 gallons per minute, and a maximum lift of 30 feet. The rate charged to settlers is £1 10s. per acre per annum, but no general rate is levied as at Curlwaa. During the 1928-29 season 167,009,040 cubic feet of water or 3,834 acre feet, were pumped with eight pumpings. The average area watered was 1,059 acres. This includes lands outside the area which are watered by a special agreement. The principal industry is dairying, milk being supplied to the town of Hay, and cream to the local butter factory.

(v) *Coomoalla Irrigation Area.* The Coomoalla Irrigation Area is situated on the Murray River about 9 miles by road from Wentworth. The land is rich chocolate loam, timbered with pine, belah, and sandalwood, and has a limestone subsoil varying from 2 feet to 10 feet below the surface. The soil is admirably suited to horticultural farming, especially viticulture. The first section at present being developed embraces 3,090 acres, of which 2,317 acres have been subdivided into 42 residential holdings and 116 horticultural farms, the average area of the latter being 19.1 acres, of which 17.3 acres are irrigable. The tenure is either perpetual leasehold or farm purchase, with a payment period of 36½ years, at the option of the settler. Water is pumped from the Murray River by steam-driven engines, operating two-stage centrifugal pumps, in duplicate, with a total capacity of 38 cubic feet per second. The rising main is of steel, 2,150 feet long, 5 ft. 6 in. diameter, and is of sufficient capacity to permit of an extension of the area later. The supply channels have been lined throughout with concrete and mortar, and the scheme also includes the construction of drainage channels, bridges, and other structures.

Settlement commenced, with the exception of one farm, about the middle of 1926. At 30th June, 1929, 109 holdings were held as leases or purchases, 97 being horticultural and 12 residential holdings. The total area of these is 1,830 acres, of which 1,296 acres had been planted, principally to sultanas and citrus.

The total value of production for the year was approximately £17,000.

During the year 1928–29 the quantity of water supplied was 204,862,680 cubic feet or 4,703 acre-feet, the average area watered during four irrigations being 1,393 acres.

(vi) *Projected Irrigation Schemes.* (a) *General.* Construction is in progress of the Hume Dam, on the Murray River, and of Wyangala Dam on the Lachlan River. The Water Conservation and Irrigation Commission is investigating schemes for utilizing the New South Wales share of the Murray waters, and has under consideration schemes for storing water for the purpose of irrigation and stock and domestic supply on the Macquarie, Hunter, Namoi and Peel Rivers.

(b) *Murray River.* The effect of constructing the Upper Murray storage will be to ensure at all times sufficient flow below Albury to permit of diversions for irrigation and stock and domestic supplies, and to make good the losses in the river due to seepage, evaporation, and lockages. The Act provides that, subject to certain conditions, New South Wales and Victoria shall share the regulated flow of the river at Albury, and shall each have the full use of all tributaries of the River Murray within its territory below Albury, with the right to divert, store, and use the flows thereof.

It is estimated that the New South Wales regulated river flow after the construction of the Upper Murray storage will amount to an average of at least 132,500 acre-feet per month at Albury during the irrigating season, and this will permit of a considerable amount of irrigation development along the river.

Construction has advanced to such a stage that 100,000 acre-feet can be stored behind the Hume Reservoir wall, and investigations are being made into the manner in which the New South Wales proportion of the Murray waters can be most profitably used, when the full storage is available.

(c) *Lachlan River.* In December, 1926, the Parliamentary Standing Committee on Public Works completed its inquiry into alternative schemes for water conservation on the Lachlan River. These comprised:—(1) construction of a large storage dam at Wyangala; (2) the raising of Lake Cudgellico; and (3) a number of low weirs between Goolagong and Booligal. The Committee recommended the construction of the Wyangala Dam, subject to some 850,000 acres of mallee country along the Condobolin–Broken Hill railway line between Euabalong and Roto being thrown open for settlement. It is proposed to serve this area with stock and domestic water, which will be diverted from the Lachlan River at the Booberoi Weir and conveyed in channels to the area. The Wyangala Dam Act 1928, assented to on 16th June, 1928, provided for the construction of a concrete dam across the Lachlan River about 6 miles below the junction of the Abercrombie River, at an estimated cost of £1,352,000. The Water Conservation and Irrigation Commission of New South Wales, was constituted the constructing authority for the work. After an exhaustive inquiry by the Development and Migration Commission, sanction was given for the funds for construction being provided under the terms of the £34,000,000 Migration Agreement. The excavation of the foundations of the dam was commenced on 17th December, 1928. The catchment area above the dam is 3,200 square miles. The formation at site is a hard grey granite which has been extensively explored with the diamond drill and constitutes a satisfactory foundation. The capacity of the storage will be about 300,000 acre-feet, and the maximum depth 165 feet. Arrangements are being completed for the whole of the preliminary works, and much of the necessary machinery has been ordered or arranged for. The expenditure to the 30th June, 1929, was £124,979.

(d) *Macquarie River.* The question of construction of a storage dam at Burrendong, together with a diversion weir in the vicinity of Narromine, and a canal therefrom to serve an irrigation area between Narromine and Trangie was also inquired into by the Parliamentary Standing Committee on Public Works, but the inquiry was not completed at the expiration of Parliament, and is remaining in abeyance for the present.

(e) *Hunter, Namoi, and Peel Rivers.* Pumping by licensed private irrigators under the Water Act of 1912 is increasing at such a rapid rate that in the case of some of the rivers, such as the Peel and the Hunter, it will not be possible adequately to supply the

pumps in dry seasons until head storage works have been constructed. Investigations are in progress for storage dams on the Hunter and Peel Rivers, for dams at alternative sites on the Namoi River at Keepit and above Manilla.

(vii) *Water Rights.* By Part II. of the Water Act 1912, the right to the use and flow and to the control of the water in all rivers and lakes which flow through, or past, or are situate within the land of two or more occupiers is vested in the Crown. Private rights are almost wholly abolished, riparian law is simplified, and a system of licences is established for the protection of private works of water conservation, irrigation, water supply, drainage, and the prevention of inundation of land. The enactment prevents litigation and determines the rights of riparian occupiers.

During the year ending 30th June, 1929, applications were received under the Water Act 1912 for 213 new licences and 265 for renewals of existing licences for pumps, dams, and other works. The new licences issued were 176 in number, while 38 were not renewed, so that on the 30th June, 1929, there were 2,339 in force. In most instances the period for which these licences are issued is five years. A fee covering the whole of the period of each licence is charged to cover the cost of administration.

(viii) *Water, Irrigation and Bore Trusts.* Part III. of the Water Act 1912 provides for the supply of water either for irrigation, stock, or domestic purposes, and for drainage of land. The liabilities thereon are repaid to the Crown, with interest spread over a period of usually from 10 to 28 years inclusive. Under the law the administration, except for the Western Division, is vested in trustees—either three or five to each trust, of whom, in the former case, one is the official trustee representing the Government, and in the latter two are official trustees acting in a similar capacity. In the Western Division the Western Land Board is appointed trustee. For the supply of water, trusts have been constituted in connexion with (a) 77 Bore Water Trusts; (b) seven schemes for the improvement of natural off-takes of effluent channels, for the purpose of diverting supplies from the main rivers; (c) in 6 instances for the construction of weirs across stream channels; (d) 10 pumping schemes; and (e) one for impounding by means of regulators water which flows into natural lakes. The area included within these trusts amounts to:—Bore Water Trusts 4,607,177 acres, and Water Trusts and Irrigation Trusts 3,557,135 acres.

In addition to the Trust Districts, there are 12 Artesian Wells Districts totalling 324,947 acres supplied with water under the provisions of Part V. of the Water Act 1912.

(ix) *Amendment of the Water Act 1912.* A measure is in preparation for submission to the State Legislature to amend and improve the existing enactments relating to the control of water in the streams of the State. The measure will simplify the procedure in respect of the issue of licences to appropriate water and to use works connected with rivers and lakes and will give effect to the practice of prior appropriation of water according to the order in which applications for licences and authorities are received. This measure will also provide for the licensing of bores sunk for water for depths greater than 100 feet and will contain provisions to enable supplies of water being given to extensive districts for domestic use, stock watering and irrigation.

3. *Victoria.*—(i) *General.* The Water Conservation Works in Victoria consist of irrigation works proper, and those providing mainly a domestic supply, such as the works for the supply of Melbourne, controlled by the Melbourne and Metropolitan Board of Works; the Coliban, Wonthaggi, Broken River, Kerang Lakes, Naval Base and Mornington Peninsula, and Mallee Supply Works administered by the State Rivers and Water Supply Commission; and other works of domestic supply controlled by Water Works Trusts or Municipal Corporations. Particulars of the works not controlled by the Commission will be found in the chapter on Local Government in this volume. With the exception of that of the First Mildura Irrigation Trust, all the irrigation schemes, and the more important domestic and stock water-supply works in rural districts, are vested in and controlled by the State Rivers and Water Supply Commission, a body composed of three members, which was created by the Water Act 1905, now incorporated in the Water Act 1928.

While not covering the whole of the activities of the State Rivers and Water Supply Commission, the particulars in the following statement will furnish a general idea of the development of water conservation and distribution in Victoria under its administration; also of the value of an efficient water supply to country lands, whether for domestic and stock purposes only, or for the addition of irrigation to lands already so supplied:—

Irrigation Districts—	At 30.6.07—	At 30.6.29—
Number of Districts administered ..	10 ..	.. 33
Number of Districts having Water Rights	Nil ..	.. 25
Total of such Water Rights ..	Nil ..	.. 398,000 acre-feet
Area under Irrigated Culture ..	108,000 acres ..	.. 472,000 acres
Valuation for Rating purposes ..	£196,000 ..	.. £763,000
Rural Waterworks Districts—		
Number of Districts administered (excluding Coliban)	3 ..	.. 30
Valuation for Rating purposes ..	£125,000 ..	.. £1,729,000
Urban Districts—		
Number of Districts administered ..	1 ..	.. 68
Valuation for Rating purposes ..	£5,600 ..	.. £523,000

The storages for irrigation and domestic and stock supply purposes had, at 30th June, 1929, a total capacity of 1,267,520 acre-feet. The completion of works now under construction will bring the total to 1,350,920 acre-feet, as against a total of 172,000 acre-feet in 1902. The Hume Reservoir, which is being constructed on the Upper Murray, already stores 100,000 acre-feet, and, when completed, will contain 2,000,000 acre-feet, half of which quantities under the provisions of the River Murray Agreement, can be credited to the State of Victoria. At the latest available date the capacity of existing storages amounted to 1,267,520 acre-feet, while when works in course of construction have been completed the total will amount to 2,300,920 acre-feet.

(ii) *Irrigation Schemes.* (a) *General.* This division comprises the schemes constructed and under construction for the supply of water to thirty-three irrigation districts. The capital expenditure at 30th June, 1929, on water supply for the irrigation and water supply districts under the control of the Commission and at Mildura, exclusive of the amount of £2,063,000 expended by it on River Murray Agreement Works, was £10,938,000. The irrigation works draw their supplies mainly from headworks constructed on the Goulburn, Murray, and Loddon Rivers. The cost of these headworks, which now stands at £1,127,000, is not debited to any particular districts, but is borne by the State. The extent of land under irrigated culture during the year 1928–29 for all kinds of crop was 471,695 acres.

(b) *Goulburn Irrigation System.* The Goulburn Irrigation System (see Official Year Book No. 13, map on page 561) is the largest project of the kind in Victoria. The need for irrigation in the Goulburn Valley is indicated by its low annual rainfall, 18 inches, while the great variation in the rainfall over the catchment area, 20 inches to 52 inches; in the rate of flow, 180 cusecs* to 80,000 cusecs; and in the volume of the annual river discharge, 620,000 acre-feet to 6,200,000 acre-feet, reveal clearly the necessity for regulating the river flow by storage. The progress made in this direction is shown by the fact that the existing storages of this system will hold some 660,000 acre-feet, which, added to 300,000 acre-feet divertible direct from the river, brings the total artificial supply to 960,000 acre-feet.

The Goulburn Scheme comprises a diversion weir on the Goulburn River, near Nagambie, which raises the summer level of the river about 45 feet to 408 feet above sea level, the height necessary to command the lands to be irrigated; two main channels,

* Cusecs — Cubic feet per second.

the eastern diverting water to the four Irrigation Districts surrounding the town of Shepparton, and the western supplying the eastern half of the Rodney main channels and filling Waranga Basin, the principal storage reservoir of the scheme. Two further main channels issue from this reservoir, one feeding the western half of the Rodney main channels, and the other serving districts as far west as Boort and continuing thence further west to the Yarriambiack Creek, distant 230 miles by channel from Waranga Reservoir. Further details in respect of this scheme are contained in previous issues of the Year Book (see Official Year Book, No. 19, page 834).

In response to requests for additional storage the Commission adopted what was known as the Sugarloaf site, just below the junction of the Goulburn and Delatite Rivers, as the most economical. A dam has been constructed to a height of 140 feet above the river bed, its foundation being in places 75 feet below the natural surface. It has an over-all length of 3,000 feet, of which 2,300 feet consist of "rock fill" bank with a reinforced concrete-core wall, the remaining 700 feet being of mass concrete, and forming a flood spillway. The dam submerges an area of 8,000 acres and permits the storage of 306,000 acre-feet of water. The catchment area above this (Eildon) reservoir is 1,500 square miles.

The State Electricity Commission has proceeded with its scheme of hydro-electric works at the Eildon Reservoir, in connexion with which the Water Commission provided a separate outlet for emergency or power purposes. Generally, the regulated flow from the reservoir required for water supply purposes can be discharged through this pipe, thus enabling it, in the whole or part, to be passed through the turbines on its way to the river.

The portion of the State at present served by the Goulburn system comprises 137,200 acres east of the river, 573,500 acres between the Goulburn and the Campaspe, 400,430 acres between the Campaspe and the Loddon, and 69,670 acres west of the Loddon. These areas include the irrigated closer settlements at Katandra, Shepparton, Stanhope, Tongala, Rochester, Echuca North, and Dingee, as well as the districts formerly controlled by the Rodney and Tragowel Plains Trusts, where the holdings are larger than in closer settlement areas. The main channels of the system have an aggregate length of 202 miles, in addition to which there are 2,540 miles of distributaries, a total for the whole system of 2,742 miles.

The balance of the area, including Deakin and Boort Districts, is provided with a domestic and stock supply, and water is sold for occasional irrigation on application. The amount of the compulsory charge for irrigation water allotted as a "right" in the older districts is at present 7s. per acre-foot in the two districts—Tragowel Plains and Dingee—farthest removed from the sources of supply, 7s. 6d. in special circumstances at Echuca North, and 6s. per acre-foot elsewhere.

The East Goulburn main channel, with a capacity of 666 acre-feet per day and a length of 32 miles to the Broken River, has supplied the Shepparton Irrigation District of about 25,000 acres—mainly Closer Settlement areas—since its inception in 1912, and is now being enlarged to 1,100 acre-feet per day, and extended to a total length of 51 miles to supply also the Irrigation Districts of South Shepparton (34,000 acres), North Shepparton (64,400 acres), and Katandra (14,600 acres). The North Shepparton District will be gradually extended as required to include additional areas served by further distributary channels completed from time to time, until the whole of the suitable area, bounded by the East Goulburn main channel on the east, the Goulburn River on the west, and the Nine-Mile Creek on the north, has been supplied. In the South Shepparton district water rights of 1 acre-foot of water to each 4 acres of irrigable land have been allotted, the compulsory charge owing to the greater cost of construction being, for the present, 8s. per acre-foot. The Waranga Western main channel (capacity 2,000 acre-feet per day at reservoir outlet) has been enlarged from 520 to over 800 acre-feet per day from the Piccaninny Creek to a point about $1\frac{1}{2}$ miles westward. From this point a new channel—the Tandarra-Calivil main—has been constructed through Dingee District (6,000 acres) and an adjoining area known as Calivil to the No. 1 main of Tragowel Plains District. This new channel came into use in September, 1926, and has since relieved the pressure on the Tragowel Plains system, which supplies an area of

212,750 acres, and released most of the capacity of the Waranga Western main channel for the delivery of supplies to the Calivil District (45,700 acres), and to supplement the supply to Boort District, previously dependent mainly on the Loddon River. This channel has been extended westward, with a view to improving the water supply conditions of the Wimmera-Mallee districts referred to later.

The development of the fruit-canning industry emphasizes the success of irrigation in the Goulburn Valley. The canneries at Shepparton and Kyabram, together with the recently established one at Mooroopna, processed during the 1928 season the largest pack of canned fruit yet produced in Victoria, the aggregate of the three canneries being 20,000,000 tins. It is estimated that about 40 million tins of canned fruit are produced yearly in Australia, of which 60 per cent. is processed by Co-operative Canneries in Irrigation Districts.

(c) *River Murray Irrigation Schemes.* The group of irrigation schemes for the service of the districts along the frontage of the River Murray, and drawing supplies direct from that river, ranks next in importance in point of development to the Goulburn Irrigation System. These schemes already supply an area of 430,000 acres, served by 1,700 miles of channels, and are capable of considerable expansion when the Hume Storage Reservoir, now under construction, becomes operative.

The districts supplied are all situated in the portion of the Murray Valley below the town of Echuca, and in an area of comparatively low rainfall. Those between Echuca and Swan Hill, excepting Tresco, are supplied by gravitation, while the Tresco district, and those lower down the river—Nyah, Merbein, Mildura and Red Cliffs—are supplied by pumping.

The present headwork of the gravitation schemes is a weir and lock at Torrumbarry—some 20 miles (by road) down-stream from Echuca—constructed under the powers conferred by the River Murray Waters Acts, the constructing authority being the State Rivers and Water Supply Commission.

This weir was commenced early in 1919 and completed in the latter part of 1923. It raises the summer level of the river by some 16 feet, and thus substitutes continuous diversion for the intermittent diversion hitherto dependent on the varying level in the river, and at the same time provides for the passing of river craft but without offering serious obstruction to the passage of floods.

These objects have been achieved by the construction of a concrete foundation, combined with movable steel trestles, which support stop bars to the height necessary to keep the river at diverting level. In times of flood the bars, and if necessary the trestles themselves, are removed to the river bank.

The effect of this work, as regards irrigation, is the ensuring of a regular supply by gravitation throughout the year to the districts between Torrumbarry and Swan Hill. The districts first benefited by this supply are those known as Leitchville, Cohuna, Gannawarra, Koondrook and Swan Hill, comprising in all 199,000 acres on the river frontage (hitherto dependent on pumping plants during low stages of river flow), and the Kerang and Mystic Park districts and adjacent areas, containing about 113,000 acres, more distant from the river which were receiving a more or less irregular supply, by gravitation, from the Kow Swamp Free Headworks. These headworks comprise a gravitation offtake at the effluence from the Murray of the Gunbower Creek; a main channel thence (the Gunbower Creek improved) to Kow Swamp Reservoir, a natural depression improved so as to hold 40,860 acre-feet; and a main supply channel therefrom (the Macorna channel) westward to the Loddon River.

The quantity of water allotted as a "right" in these districts is 1 acre-foot per irrigable acre. The compulsory charge is at present 6s. per acre-foot of such water rights. In Kerang district—not yet under a compulsory irrigation charge—water is sold to irrigators on application at a charge not exceeding 4s. per acre-foot of water supplied. The districts supplied include the Cohuna, Koondrook, and Swan Hill Closer Settlement Estates, comprising in all 34,000 acres. Of this area, 8,000 acres were specially purchased for soldier settlement, the channel systems being correspondingly extended.

In addition to stabilising the supplies to existing irrigation districts, the Torrumbarry weir will enable large areas adjacent to these districts to be commanded by extensions of existing gravitation channel systems. The most important works so far constructed for this purpose are (a) the Gunbower-Cohuna Main Channel, which with the necessary distributaries provides water for irrigation for the new Leitchville Irrigation District of 10,000 acres situate between Kow Swamp State Works and the Cohuna Irrigation District; (b) the distributary channels of the Mystic Park area (18,000 acres); (c) the main channel and distributaries for the Third Lake Irrigation District (12,100 acres); and (d) the distributary channels for the Fish Point Irrigation District (5,800 acres) adjoining the Little Murray River. The water rights allotted are—in Mystic Park 1 acre-foot, Third Lake 2 acre-feet to every 3 acres of irrigable land, and in Fish Point area 1 acre-foot to every 2 acres of irrigable land. The compulsory charge is at present 6s. per acre-foot in Mystic Park District, 7s. per acre-foot in Leitchville and Third Lake Districts, and 8s. per acre-foot at Fish Point.

Extensions of irrigation schemes dependent on the River Murray, hitherto impracticable owing to lack of storage on that river, will be rendered possible on the completion of the Hume Reservoir. This storage work, now in course of construction jointly by the States of New South Wales and Victoria, is one of the works authorized by the River Murray Waters Acts. (Detailed reference to this undertaking will be found at the end of this section.) The site of the dam is a little below the junction of the Murray and Mitta Rivers. The catchment area is about 6,000 square miles of mountainous country. A reservoir of a capacity of 2,000,000 acre-feet would submerge some 69 square miles—about four times the area of Sydney Harbour.

The irrigation areas supplied by means of pumping, and not commandable by gravitation from the Torrumbarry offtake, stated in geographical order, are the Tresco Irrigation District, the Nyah and Merbein Murray Frontage Settlements, the First Mildura Irrigation Trust District, and the Red Cliffs Soldier Settlement.

The Tresco District of 4,000 acres, created by private enterprise, and later taken over by the State Rivers and Water Supply Commission, is supplied by water lifted from Lake Boga by pumps throwing 80 acre-feet per day. Its channel mileage is 50. The water supplied is 2½ acre-feet to each irrigable acre, and the compulsory charge at present £2 per acre.

The Nyah Irrigation Area is supplied with water diverted from the Murray by a high-lift pumping plant—capacity, 94 acre-feet per day. The total length of the channels is 53 miles, of which 44 miles are lined with concrete. The settlement contains 3,800 acres, subdivided into 236 holdings of an average area of 15 acres—practically all settled. The settlers include 64 discharged soldiers. Water rights are apportioned to these holdings on the basis of 2½ acre-feet of water for each irrigable acre, and the compulsory charge is at present 20s. per acre-foot of such water rights. The land is devoted mainly to vineyards and orchards, and the settlers, taken as a whole, are making good progress. The value of irrigation to the district is reflected in the selling price of the land, fully planted blocks bringing remarkably high prices.

The Merbein Irrigation Area comprises 8,400 acres, originally Crown lands. This settlement now contains 418 holdings, averaging 20 acres each, practically all settled, the settlers including 158 discharged soldiers. The water is obtained from the Murray by pumps, which deliver 225 acre-feet per day. The main and distributary channels have a combined length of 60 miles. The land settlement conditions and the water rights apportioned are the same as at Nyah, but the compulsory charge is 24s. per acre-foot. The Merbein Works supply also the adjacent Yelta Waterworks District of 48,500 acres.

The Red Cliffs Irrigation Settlement comprises an area of 18,000 acres including the township and 15,000 acres of first class irrigable land adjoining the Mildura Settlement. It is the irrigable portion of the large Red Cliffs estate of 33,000 acres, known as the Debenture Holders' Land, acquired by the State for soldier settlement. The scheme of works for this district ranks first in importance among Victoria's pumping systems. It includes a pumping plant capable of delivering 500 acre-feet of water

per day, lifted 105 feet, a reinforced concrete rising main 6 feet 6 inches in diameter, 34 chains long, two electric generators each of about 350 k.v.a. capacity, to provide for relifts, and a system of main and distributary channels to command every holding in the district. The three pumping units have already been installed and are in operation. The total length of channels constructed to date is 124 miles, the excavation involved totalling 665,000 cubic yards. Channels having a length of 114 miles have been lined with concrete, with the result that 99 per cent. of the blocks in the settlement are protected from seepage. About 680 discharged soldiers have been allotted blocks on this settlement. The Red Cliffs township, which is growing rapidly, has been proclaimed an urban division of the Irrigation District, and is supplied with the necessary reticulation from a concrete stand pipe 70 feet high and 26 feet in diameter. The Red Cliffs works supply also the adjacent Carwarp and Carwarp Central Waterworks Districts having a total area of 206,000 acres.

The area planted to date consists of 10,100 acres of vines and citrus trees. The first harvest (1924) returned 570 tons of dried fruit, in addition to which large quantities of table grapes were sold for consumption. The 1929 harvest produced 17,000 tons of raisins, currants, and sultanas, in addition to large quantities of grapes sold for dessert and distillation.

(d) *Loddon River Scheme.* This also is wholly a gravitation system, with a regulating weir on the Loddon at Laanecoorie as its headwork. Its storage capacity is 14,000 acre-feet, and other works include timber diversion weirs at Serpentine and Kinypanial, and 243 miles of channels which supply an area of 79,000 acres in the Boort district for domestic and stock purposes and partial irrigation, and a considerable portion of the adjoining Loddon United Waterworks Trust District with water for domestic and stock use.

(e) *Werribee River Schemes.* (1) *Bacchus Marsh.* The headwork of this gravitation scheme is a reservoir of 15,000 acre-feet capacity on Pyke's Creek, a tributary of the Werribee, the intake from the creek catchment being supplemented by a tunnel through a dividing spur, which taps the Werribee River near Ballan. The area of the district is 6,700 acres—half of which is irrigable and includes some of the richest lucerne land in the State. The annual water right is one acre-foot per irrigable acre, and the present compulsory charge is 22s. 6d. per acre-foot of such right. The higher portion of the district receives a supply for domestic and stock purposes.

(2) *Werribee.* This is another gravitation scheme on the same river, with a reservoir of 17,000 acre-feet capacity at Melton as its headwork. The irrigation district comprises 10,000 acres of first-class land, being the irrigable portion of the Werribee Closer Settlement Estate, which is within 20 miles south-westerly of Melbourne. The water-right allotment is one acre-foot per irrigable acre, and the charge at present is 12s. per acre-foot. The non-irrigable portion of the estate, containing about 13,000 acres, is supplied with water for domestic and stock purposes.

(f) *Macallister River (Maffra) Scheme.* The works of this scheme, the first irrigation scheme in the south-eastern portion of the State, now in course of construction, comprise a storage reservoir on the Macallister River, at Glenmaggie near Heyfield, and a system of main and distributary channels capable of commanding by gravitation some 80,000 acres of the rich river flats along the Macallister, Avon, and Thomson Rivers, near Maffra, Stratford, and Sale. The conditions in these areas as to quality of lands and annual rainfall are similar to those at Bacchus Marsh and Werribee before irrigation. The design of the dam—a large cyclopean concrete structure 1,000 feet in length—provides for the raising of water to a maximum height of 100 feet above the foundations. The catchment area above the dam is 813 square miles and the area submerged at full supply level will be 4,500 acres, while the capacity of the storage will be 150,000 acre-feet, and the unregulated flow of the river will yield an additional 100,000 acre-feet. The construction of the works is practically complete. Approximately 105,000 acre-feet of water can now be stored, and arrangements can be made to store the whole volume of

150,000 acre-feet when required. The commanded lands are specially suitable for beet culture and dairying, and include some 11,000 acres acquired by the State Rivers and Water Supply Commission for soldier settlement. The area first supplied was 8,000 acres of the Avon River flats, including the Boisdale Closer Settlement Estate, and was constituted the Maffra Irrigation District in 1927. This district was subsequently extended to include a total supplied area of 23,000 acres. Further extensions of the channels enabled supplies to be given to settlers on some 6,000 acres of closer settlement estates, and 9,000 acres of private holdings in the vicinity of Sale, and the Sale Irrigation District of 15,000 acres was constituted accordingly, making the total area now served by the Maffra-Sale system 38,000 acres. Outlets for the produce of irrigated farms are already provided by the sugar, butter, and condensed milk factories, which are within easy reach, while the proximity to railway stations ensures to settlers the necessary transport facilities.

(iii) *Domestic and Stock Schemes.* (a) *General.* The second division takes into account the schemes constructed and under construction for the supply of water for domestic and stock purposes, the capital expenditure on which at 30th June, 1929, was £9,000,000. The area of country lands artificially supplied with water for these purposes is 23,953 square miles. The number of towns supplied, exclusive of the City of Melbourne and its suburbs, is 218, serving an estimated population of 386,800. In addition to the Commission's districts, some large areas are still administered by local authorities.

(b) *Wimmera-Mallee System.* The principal scheme in this division is that known as the Wimmera-Mallee Gravitation Channel System. This comprehensive scheme of works will compare favourably, it is believed, with any similar individual scheme for domestic and stock service in any part of the world. The main supply is drawn from five reservoirs in the catchment area of the Wimmera River, at the foot of the Grampians Ranges, viz. :—Lake Lonsdale, Wartook, Fyans Lake, Taylor's Lake, and Pine Lake. The reservoirs in use, including some minor works, have a combined storage capacity of 183,080 acre-feet. The completion of the works in progress will bring this total to 213,080 acre-feet. The water is conveyed partly by natural watercourses but chiefly by artificial channels aggregating 5,720 miles in length over farming districts comprising about 11,000 square miles, approximately one-eighth of the whole State (see Official Year Book No. 13, map on page 562). This system also furnishes supplies for 36 townships controlled by the Commission, and 6 towns controlled by local Waterworks Trusts or Shires. The construction of the new main channel from the Wimmera River at Glenorchy to the important town of Charlton on the Avoca River provided not only a full gravitation supply of good quality to that town, in lieu of the poor unsatisfactory supply previously pumped from the Avoca River, but, in addition, greatly improved supplies for domestic and stock purposes to about 236,000 acres in the districts of four local Waterworks Trusts, and the area so served has, with the concurrence of those bodies, been added to Waterworks Districts under the jurisdiction and control of the Commission. As this area included the entire districts of the West Charlton and Shire of Donald Waterworks Trusts, these trusts were abolished under the provisions of the Water Acts.

The rainfall on the Wimmera catchment during the last few years has been so light that watering had to be commenced with partially depleted storages. There has been a considerable increase in the quantity of water used in both urban and rural districts, as the average capacity of farmers' storages has doubled during the last fifteen years, and the consumption in urban districts has risen to 80 gallons per head per day, as compared with a consumption of 56 gallons per head for Melbourne.

The Commission, after consideration of these facts, has extended the Waranga Western Main Channel north-westerly for about 130 miles west of the Loddon River to the Yarriambiack Creek, in order to supplement the Wimmera-Mallee supplies from the more permanent streams to the eastward during winter periods, when water could be made available without affecting irrigation supplies. This extension commands practically the whole of the area served by the Wimmera-Mallee system north of the 36th parallel, thus leaving the Wimmera catchment available for the southern portion of the area dependent on the system.

(c) *Northern Mallee Water Supply Scheme.* In what is known as the northern Mallee, an area of about 1,250,000 acres, adjoining the Wimmera-Mallee Gravitation Channel System, but above its channel level, the Commission has provided a water supply for the large wheat holdings in the Walpeup and adjoining districts, by means of bores and large public tanks. The number of successful Government bores in use in this area is 99, their average depth being 460 feet. There are also 260 tanks, having a total capacity of 1,210,000 cubic yards, or 204 million gallons.

(d) *Carwarp Scheme.* The works of this scheme—a system of distributary channels—were constructed to provide domestic and stock supplies for an area of 215,300 acres of Mallee lands situated immediately south of the Red Cliffs Irrigation District and traversed by the Mildura Railway, the supply being drawn from the Red Cliffs pumping station. The whole of this area was at first embraced within the Carwarp Waterworks District, but, subsequently, an improved supply was given to some 15,000 acres around the railway station, and above the general level of the surrounding country, by means of a pump and rising main, with 13 miles of channels. The high lands so supplied have been constituted the Carwarp Central Waterworks District, and some 14,000 acres were transferred to the Millewa District.

(e) *Millewa Scheme.* This recent and important addition to Victoria's water supply schemes for domestic and stock purposes is designed to serve 1,000,000 acres of the extreme northern Mallee between the Mildura railway and the South Australian border, which has been opened up for settlement by this water supply scheme, and the construction of 55 miles of railway from Red Cliffs westward toward South Australia. The water for this extensive area is drawn from the River Murray. The scheme comprises two main lifts, of about 113 and 145 feet respectively, the first lift being from Lake Cullulleraine on the flats 5 miles from the Murray. This lake, the main storage of the scheme, which holds 2,000 acre-feet, will be filled from No. 9 Lock now in course of construction. Holdings aggregating 600,000 acres have already been allotted to 421 settlers, and, for the service of this area, 670 miles of channels have been excavated, and 37 earthen storages, with a combined capacity of 361,000 cubic yards, have been constructed at convenient distances from railway stations. The first unit of the pumping scheme and the rising main having been completed, water was turned into the channels and storages early in 1924, and in May and June of that year the whole occupied area received a supply of water by channel. The extension of the pumping stations to their final capacity is being proceeded with. The Millewa Waterworks District constituted in 1924 with an area of 250,000 acres has been extended, as the works progressed, till some 619,000 acres are being served. This area includes 209,000 acres above the general level of the district which is being supplied by a relift pumping plant, and which in view of the higher cost of supply has been constituted a separate district known as Millewa Central Waterworks District. The construction of the remaining works of the scheme will precede the throwing open of additional lands for settlement. In this area and the adjacent Sunset country, 80 tanks have been constructed with a total storage capacity of 110,700 cubic yards. The township of Werrimull receives an urban supply for a population of 150.

(f) *Coreena Waterworks District.* A scheme to supply an area of 212 square miles between Tyntynder Waterworks District and the River Murray, but too high to be commanded by the Wimmera-Mallee Irrigation System, has been established at the request of the landholders, mostly returned soldiers. The works comprise a pumping plant on the River Murray, 20 miles below Euston, to deliver 15 cusecs through a 27-in. diameter steel rising main, 60 chains in length, to a high ridge from which 130 miles of main and distributary channels will eventually distribute supplies for domestic and stock purposes. The maximum lift will be 91 feet. The area served has been constituted the Coreena Waterworks District, and the mileage of channel is at present 91.

(g) *The Coliban System* comprises two main storage reservoirs on the Coliban River on the northern slope of the Dividing Range, the "Upper Coliban" with a capacity of 25,700 acre-feet, and "Malmsbury" with a capacity of 12,300 acre-feet, together with main and distributary channels aggregating 340 miles in length, 28 subsidiary reservoirs with a total capacity of 6,910 acre-feet, and 300 miles of urban pipe reticulation. This scheme supplies water for domestic and stock purposes to the city of Bendigo, also to Castlemaine, Maldon, and eighteen other townships, and the interjacent rural districts

containing in all about 176,000 acres. The population served is 61,000. This system also supplies the demands of the quartz and sluice mining industries throughout this area, and provides water for irrigation for orchards, market gardens and similar purposes, the area irrigated annually being about 8,000 acres.

(b) *Naval Base and Mornington Peninsula Scheme.* Another scheme in this division which calls for mention here is the Naval Base and Mornington Peninsula Scheme. This comprehensive scheme—prepared at the request of the Naval Authorities—is for the supply of water to the Flinders Naval Base, at Crib Point, and for the service of nineteen other townships, including the bayside resorts at Aspendale, Edithvale, Chelsea, Carrum, Seaford, Frankston, South Frankston, Mornington, and Mount Martha, and the inland townships of Beaconsfield, Berwick, Dandenong, Noble Park, Spring Vale, Pakenham, Cranbourne, Somerville, Hastings, and Bittern. An ample supply of water is obtainable both for ordinary domestic and stock use and for market gardening, in the vicinity of Dandenong, from the headwaters of the Bunyip River, which drains some 30 square miles of forest country above the point of off-take.

The scheme was extended to supplement the supply to the township of Dandenong previously controlled by a local Trust, the works of which were then transferred to the Commission, which administers them as part of the general scheme. The expansion of the reticulation systems in this district having necessitated the provision of additional supplies to meet the demand during dry periods, the Commission has constructed a new Main Supply Line from Toomuc Creek to the headwaters of the Bunyip River. This extension, which includes 25 miles of open race and 8 miles of 2-ft. pipes, has proved conclusively the value of that river as a source of supply for the Mornington Peninsula areas. A storage reservoir is being constructed near Dandenong.

An important development of this scheme was the purchase by the Commission of 3,300 acres of land in the vicinity of Narre Warren, on the main Gippsland railway, for closer settlement under irrigation. This land, which is within about 25 miles of the metropolis, is being subdivided into blocks of 10 to 15 acres, suitable for market gardening and other forms of intensive culture. Drainage works are being provided where necessary, and every block will receive a satisfactory supply of water under pressure from a pipe system connected with the main race. Electricity for all purposes will be available from the works of the Electricity Commission. The land is being settled under the ordinary closer settlement conditions, and there is a good demand for the blocks.

(i) *The Bellarine Peninsula Works.* The long-felt need of an efficient water supply for this peninsula, including the towns of Portarlington and Queenscliff on Port Phillip Bay and the seaside resorts along the south-western coastline of that area, led to investigation of proposals for a similar scheme to serve these areas by supplies drawn from the headworks of the Barwon River. A comprehensive scheme is now in progress and comprises a storage reservoir at Wurdee Boluc, an inlet channel tapping tributaries of the upper Barwon, a main outlet channel to a pipe head basin at Waurm Ponds, a pipe main thence to Geelong and to the main distribution basin near Drysdale, and channels and pipe mains thence to local service basins for the peninsula towns, also separate channels from the main outlet channel to service basins for Torquay and Anglesea. The construction of the first stage of Wurdee Boluc storage has been completed, also 42 miles of the main inlet channel, and 3 miles of 24-in. pipe main from Waurm Ponds pipe head basin to the branch main which serves Geelong.

(j) *The Kerang North-West Lakes Works* consist of a chain of lakes, situate a few miles to the north-west of Kerang, connected by channels to each other and to the Loddon River, and improved so as to be capable of storing 92,000 acre-feet of water. This system serves, for domestic and stock purposes, an area of 49,000 acres, constituted the "Kerang North-West Lakes Waterworks District." The supply from the Loddon River was insufficient and the lakes are filled by gravitation from the Torrumbarry Weir, on the River Murray, via the Kow Swamp Irrigation Works. The water is diverted along Sheepwash Creek—an improved natural effluent from the Loddon—the river level having been raised by a concrete weir at Kerang. As in the Coliban District,

water is sold on application for irrigation purposes, about 5,500 acres having been irrigated annually from this source for some years. These irrigation facilities have been so appreciated that, in response to a demand, about 30,000 acres were excised from this district and constituted the Mystic Park and Third Lake Irrigation Districts. (See page 645 *ante*.)

(k) *The Broken River Works* comprise two weirs—"Casey's" and "Gowangardie"—above Shepparton, and offtake works therefrom, for the diversion of water into the channels of the Tungamah, Shepparton, and Numurkah Waterworks Trusts.

(l) *The Wonthaggi Works* comprise a storage reservoir on Lance Creek, capacity 421,000,000 gallons, a main pipe line therefrom 9 miles in length to the coal-mining towns of Wonthaggi and North Wonthaggi, a service reservoir—capacity 1,400,000 gallons, and 24 miles of pipe reticulation for the service of those towns. The population supplied is 10,000, and there is a service to the State Coal Mine and Railways Department.

(iv) *Flood Protection*. The Water Acts of Victoria provide for the constitution of Flood Protection Districts, in which the residents are rated for schemes carried out for their benefit. The works are constructed, and districts administered by the State Rivers and Water Supply Commission, and the Commission has carried out extensive schemes at Koo-wee-rup and Cardinia, in the south-eastern portion of the State, at Loch Garry and Kanyapella on the Goulburn River between Shepparton and Echuca, and works on a smaller scale at the town of Echuca.

The Koo-wee-rup and Cardinia Flood Protection Districts together embrace the whole of a large continuous depression south of the main Gippsland railway and along the sea-board of Westernport, containing in all about 100,000 acres of very fertile country, the proper development of which was seriously retarded by periodical inundations. A large portion of the land was reclaimed, subdivided, and settled by the State, but it became evident, during periods of heavy rainfall, that only a comprehensive drainage scheme for the whole area affected would afford the needed protection from flooding.

At the request of the settlers, the Commission prepared schemes for this purpose, and, after the concurrence of the settlers had been obtained, practically carried the schemes into effect, and the two large districts above-mentioned were constituted, and are now being rated on an acreage basis in respect of benefits derived from the works. The Commission's works are now well advanced, and provide flood protection from all but abnormal floods, and the duration of even these is considerably shortened and their effect correspondingly lessened as the result of the works, which consist of the substantial enlargement and remodelling of most of the existing principal drains, the construction of new internal drains, and the cutting of several distinct outlets, thus avoiding concentration of flood waters in the main drains.

The Loch Garry Flood Protection Works comprise about $5\frac{1}{2}$ miles of earthen levee banks around Loch Garry, and a concrete regulator and spillway 400 feet in length, to control overflows from the loch. The purpose of the scheme is to protect some 40,000 acres of lands previously flooded by overflows of the Goulburn River by way of Loch Garry and Bunbartha Creek. The Kanyapella Scheme provides for the conservation of a domestic and stock supply in Warrigal Creek, and the exclusion therefrom of certain flood waters. The area benefited is 13,500 acres. Both schemes have been approved by a majority of the landholders concerned and are now in operation.

(v) *Mildura*. The Mildura Irrigation Scheme is controlled by the First Mildura Irrigation Trust, and water is obtained by pumping from the River Murray. The area of the settlement is 45,000 acres, of which 14,000 acres are under intense culture, vines predominating. During the year ending 30th June, 1929, the Trust's receipts aggregated £48,944, and its expenditure £36,242; whilst loans—exclusive of £17,437, arrears of interest—advanced by the Government, amounted at 30th June, 1929, to £96,837. The number of water-acres supplied during the year was 52,726.

4. Queensland.—The main irrigation works in Queensland are as follows :—

(i) *Dawson Valley Scheme.* The Dawson Valley Irrigation Scheme, now in its initial stage, comprises :—(a) A concrete dam at Nathan's Gorge, some 30 miles below the town of Taroom, to impound 2,500,000 acre-feet of water : (b) an offtake weir 80 miles down stream for the diversion of water for the irrigation of 70,000 acres in the Dawson Valley ; and (c) Theodores Zone (see below).

The Dawson River rises in the Great Dividing Range. The catchment above the proposed Nathan Dam is 9,000 square miles, over which the average annual rainfall is 27 inches. An arched dam is involved, with termini on lines tangential to the curve. The rock forming the foundations is a hard sandstone, the crushing strength of which ranges from 3,000 to 5,000 lb. per square inch. It is designed to fix the water level 130 feet above summer level at the site, and the crest height at 145 feet, with a spillway on the left bank. The crest length of the dam will be 860 feet, 500 feet on the curved portion. The reservoir will be the largest artificial storage in the world.

An approach road from Wandoan Railway Station to the dam site has been under construction during the year. This is 54 miles in length and now available for traffic, so that the carting of plant and materials for the construction of the Nathan Dam can be commenced at an early date.

The irrigable lands are of a good agricultural type with fair capillarity, ample humus, and containing liberal amounts of all mineral plant foods in readily available form. About 120,000 acres are commanded on the eastern side of the river, and 80,000 on the western side. A hydro-electric station at the Nathan Dam may utilize the water power to irrigate high level lands not commanded by gravitation, provide stock and domestic supplies to dry areas, power for factories, and light throughout the settlement.

The Dawson Valley is situated in the Central Division of the State, which comprises 209,340 square miles, or nearly one-third of the total area of Queensland. The population is less than one person to two square miles, and subtracting those resident in the principal towns, the ratio is one inhabitant to four square miles, although there is only a comparatively small proportion of inferior land in the whole area. This irrigation scheme not only provides an opportunity for increasing population and extending agriculture, but will also form a fodder reserve area for pastoral lands where rainfall is insufficient for agriculture, and water conservation impracticable. A fodder conservation proposal is being considered for the early stages of settlement with this end in view, and to give settlers an opportunity readily to dispose of some of their produce.

A railway line is constructed through the irrigation areas from the terminus of the Dawson Valley line at Baralaba to Theodore, the first zone to be settled.

In order to minimize heavy interest charges accruing during the process of construction, the project has been designed on the zone system, by which one area is prepared for settlement and completed before the next zone is proceeded with. Five zones have been designed, each comprising a certain area of irrigated land attached to a considerable acreage of dry lands. The dry lands will be allotted in proportion to irrigated land held. Though forming an integral part of the gravitation system, each zone will be a separate entity, served by its own central township, and in close connexion with the Dawson Valley railway system.

Theodore Zone. On the completion of all necessary works for irrigation purposes the Theodore zone of 30,000 acres was thrown open for selection on 1st November, 1926, and by the 30th June, 1928, 258 farms were occupied. This area is divided into 373 farms, of which 264 are irrigated and 109 are attached dry farms. A considerable proportion of the latter consists of good vine scrub land, and all is classed as soil suitable for agriculture, on which dry areas products such as wool, butter, cotton, etc., can be raised in conjunction with an irrigation farm, as an insurance over dry periods. The rich country back from the river flats is expected to form a great attraction to settlement. The pumping station established on the river operated satisfactorily during the past year. The river bank at this point is higher than the surrounding 5,000 acres, so that

when the water is pumped up, the channels radiating from the Power Station carry it by gravitation. Local storage of over 5,000 acre-feet has been obtained by the erection of a timber and earth weir below the pumping station, the crest of which is 13 feet above ordinary summer level of the river.

(ii) *Inkerman Irrigation Area.* This area embraces a total of approximately 58,000 acres and is located in a delta of the Burdekin River in the Home Hill—Ayr district 57 miles inland from Townsville. Ample supplies of water are located in shingle and sand underlying fertile soil, and irrigation is accomplished by means of electric motor-driven pumping sets located in concrete-lined walls at suitable points throughout the area. At the commencement of the scheme, tests were made on the supply bed by pumping at the rate of 1,000 gallons per minute for 14 days continuously without any appreciable diminution in the supply. The scheme comprises a central power-house equipped with two steam turbine driven generating sets giving 6,600-volt, 3 phase A.C. current which is transmitted over approximately 100 miles of H.T. overhead lines throughout the area to transformer sub-stations located near the pumping sets. The H.T. current is then reduced to 415 volts by means of transformers and fed to the motors operating the pumps which discharge into head ditches direct on to the land to be irrigated.

At the present date, there are 196 blocks in occupation with an average area of 100 acres each. Approximately 6,000 acres are continuously under irrigation, the crops comprising sugar-cane almost exclusively. To supply the demand there has been provided 202 pumps, 219 motors, ranging in size from 5 to 95 h.p. and 145 transformers. Pumps vary in capacity from 35,000 gallons per hour to 180,000 gallons per hour discharge the highest pumping head being 88 feet.

The installed capacity of the power house is 2,650 kw., a supply being also given to the township of Home Hill where 170 consumers are provided with domestic power and lighting.

The following statistics show the growth of the Area :—

Year.	Total Units generated.	Units supplied to Township.	Units used on Irrigation.	Number of Days Irrigation.	Average Acres under Irrigation.	Tons of cane crushed.	Average tons per acre.
1926-27 ..	2,626,099	34,887	1,763,445	164	4,763	126,000	26·5
1927-28 ..	2,196,861	36,679	1,586,842	170	5,065	103,137	20·3
1928-29 ..	2,130,706	57,773	1,538,557	168	5,258	140,808	26·7

The maximum load carried by the power-house, and the coal consumed, &c., are given below :—

Year.	Average Load Carried.	Maximum Load Carried.	Coal Consumed.	Average Cost per Ton.	Pounds of Coal per unit Generated.
	kw.	kw.	tons.	£ s. d.	
1926-27.. ..	740	1,470	3563·5	1 11 2	4·44
1927-28.. ..	720	1,750	3322·0	1 7 4½	4·58
1928-29.. ..	900	1,940	3015·5	1 6 5	4·35

(iii) *Other Schemes.* Smaller schemes include Townsville (wells, creek, and river); Rockhampton (wells, river, creek, etc.); those at Bingera, near Bundaberg, which utilize water pumped from the Burnett River just above the point of meeting of the salt and fresh waters; and those at Fairymead, which utilize water pumped from a number of shallow spear wells sunk on the alluvial flats on the north side of the Burnett River and about 6 miles from Bundaberg.

5. South Australia.—(i) *The Renmark Irrigation Trust*. The Renmark Irrigation Trust was established on similar lines to Mildura, but on a smaller scale. The area of settlement is 23,000 acres, and the irrigated area 7,700 acres, while the population of the town and settlement is 4,800. Water is obtained from the Murray by gravitation and by pumping. The main pump situated on the river bank lifts the water into a large lagoon, from which three other pumps of 17 feet, 26 feet, and 27 feet-lift raise the water and irrigate 950, 4,200, and 1,800 acres respectively. A fifth pumping plant again lifts the water 26 feet and irrigates 750 acres. The total length of the channels is 78 miles, and of roads 98 miles, while the annual water rate is £2 5s. per acre. Cultivation on the settlement is as follows: Sultanas, 2,441 acres; currants, 1,335 acres; gordos, 922 acres; doradillos and wine grapes, 404 acres; pears, 155 acres; apples, 8 acres; apricots, 292 acres; peaches and nectarines, 109 acres; citrus fruits, 438 acres; figs, 11 acres; prunes, 7 acres; olives, 39 acres; miscellaneous fruits, 16 acres; and the balance in fodder crops. The most up-to-date and largest fruit-packing shed in the State is situated at Renmark, and is co-operatively owned, as is also a large distillery for the manufacture of grape spirit. There are several private packing sheds and a private distillery.

(ii) *Other Waterworks*. A number of country waterworks is under the control of the Public Works Department. As, however, they are not irrigation works properly so called, but are used for supplying water for domestic purposes, etc., to several towns, no further reference will be made to them in this chapter. (See chapter on Local Government.)

(iii) *Areas under Irrigation*. The Irrigation Areas on the River Murray above Morgan under Government control up to the end of December, 1929, contained 27,895 acres of irrigable land, of which 19,205 acres were allotted to 1,087 settlers, including 485 returned soldiers. The pumping plants at present installed or being installed on these areas aggregate 7,653 brake horse-power, with a pumping capacity of over 12 million gallons per hour. These lands are devoted almost entirely to fruit growing, including citrus, deciduous and vine fruits.

The *Cadell Irrigation Area* is 7 miles by river above Morgan, and comprises 2,727 acres, of which 1,098 are irrigable. Blocks have been allotted to 49 soldier settlers and 9 civilian settlers. The area is suitable for fruit growing. The pumping plant is a 190 b.h.p. steam plant, with a capacity of 4,200 gallons per minute against a head of 75 feet. Two semi-Diesel crude oil pumping plants of 25 and 35 h.p., and having capacities of 417 and 700 gallons per minute respectively, have been installed to deal with seepage water. This area was first allotted on 30th September, 1919.

The *Waikerie Irrigation Area* is situated 39 miles above Morgan by river. It is settled by 250 settlers (10 of whom are soldier settlers) occupying 10,166 acres, of which 3,384 acres are irrigable.

The area is divided into three divisions, viz., the Waikerie, Ramco, and Holder Divisions. The Waikerie and Ramco Divisions comprise 9,290 acres, of which 3,354 acres are irrigable, and the Holder Division contains 2,486 acres, of which 452 acres are irrigable.

The irrigable land is used for the cultivation of fruit trees and vines.

These three divisions were originally village settlements established in 1894 for the relief of the unemployed. The communistic form of control was not successful and the schemes reverted to the Crown.

The irrigable areas were subsequently increased by pumping to higher levels, land in the extension areas being first allotted in 1910.

Pumping Plants. Three Diesel units totalling 1,170 b.h.p. have replaced the four suction gas and one steam units. Their combined capacity is 16,667 gallons per minute against a total head of 140 feet.

Two of the old suction gas units of a total b.h.p. of 560 and a capacity of 5,833 gallons per minute have been retained as stand-by plants.

Holder Division consists of two steam units, with a total of 238 b.h.p. and a capacity of 3,750 gallons per minute against a total head of 115 feet. An adjoining irrigable area of 110 acres held by Holder Limited is also irrigated by the above units. This plant, however, will be superseded by a gravitational scheme from the Waikerie channels.

The *Kingston Irrigation Area* is situated 75 miles above Morgan by river, and comprises the old village settlement of that name. It has a total area of 3,795 acres, of which 470 acres are irrigable, and has been allotted to 35 settlers. The water is pumped by a 130 b.h.p. steam plant with a capacity of 2,000 gallons per minute against a total head of 114 feet.

The *Moorook Irrigation Area*, adjoining the Kingston Area, contains 5,971 acres of land, of which 613 acres are irrigable. All of the irrigable land has been allotted to 40 settlers, of whom 9 are soldier settlers. The control of the original scheme was taken over by the Government in February, 1915, and the area to be irrigated was extended. The first allotment of the extension area took place in March, 1916. This area is irrigated by a 430 b.h.p. steam plant of two units, with a capacity of 7,160 gallons per minute against a total head of 120 feet.

The *Cobdogla Irrigation Area* is on the opposite side of the river to Kingston and Moorook Areas. It was formerly a sheep station held under pastoral lease, and was resumed by the Government for irrigation purposes. The total area of the station was 160,000 acres, of which 23,400 acres has been set apart as the Berri Area, and the remaining 136,600 acres as the Cobdogla Area. The latter area includes Lake Bonney, 4,000 acres in extent. This lake is situated 3 miles inland from the Murray from which, now that No. 3 Lock is in operation, it is kept partially filled by Chambers Creek.

The Cobdogla Area contains about 34,500 acres of land capable of being irrigated. It is divided into 5 sections, viz., the Cobdogla, Nookamka, Loveday, McIntosh, and Weigall divisions. The 73 civilian and 150 soldier settlers on the area occupy 4,536 acres of irrigable land and 53,984 acres of dry land. The first allotment took place in 1918.

The Cobdogla division has been developed as a low-lift area, the pumping head being about 34 feet, to irrigate 1,405 acres of land. About one-half of this is devoted to lucerne and other fodders for sheep raising.

The Nookamka division, south of Lake Bonney, has an irrigable area of 2,503 acres.

The Loveday division has an irrigable area of 8,627 acres. The reticulation on this division is by means of concrete pipe lines, for both mains and branches, instead of open channels.

The *Weigall Division* contains approximately 9,000 acres that could be irrigated, but with the falling off in the demand for land for fruit growing, no development work has been undertaken. A number of small blocks has been allotted for dry farming to settlers who hold irrigable land in adjoining areas, and the remainder of the division has been divided into 9 blocks of about 3,000 acres in area for grazing and cultivation and let under Miscellaneous Lease.

The *McIntosh Division* contains approximately 14,150 acres, subdivided into 13 large holdings to be let as dry land under Miscellaneous Lease. There are 7 civilian settlers.

Pumping plants have been installed to supply water to the Cobdogla, Nookamka and Loveday divisions. On the Cobdogla division a 240 b.h.p. steam plant with a capacity of 16,700 gallons per minute has been installed and is now used as a subsidiary plant. The main water supply is obtained from the two "Humphrey" gas plants installed with a combined capacity of 47,600 gallons per minute. The Nookamka division has two steam units, totalling 640 b.h.p., installed with a combined capacity of 12,500 gallons per minute, which have recently been superseded by a pipe line connecting with the Loveday water mains, which now supply the Nookamka requirements. The Loveday division has a 300 b.h.p. suction gas unit, with a capacity of 6,000 gallons per minute, and two steam units installed, with combined power and output of 1,315 b.h.p., and 33,300 gallons per minute respectively, pumped against a total head of 93 feet.

The *Berri Irrigation Area* is 120 miles above Morgan by river, and contains a total area of 23,400 acres, of which 7,802 acres are suitable for fruit and vine culture. A total of 7,561 acres of irrigable land has been allotted to 437 settlers, of whom 230 are soldier settlers. An area of 80 acres of the irrigable land is used as an experimental farm. The first allotment of the older portion of this area took place in January, 1911. The pumping plant consists of five units, three suction gas and two steam units, with a total of 2,250 b.h.p., and a capacity of 42,500 gallons per minute against total heads varying from 50 feet to 120 feet.

The *Chaffey Irrigation Area* comprises a large area of country adjacent to Renmark. Preliminary survey work has been carried out over 14,000 acres of prospective irrigable land. A portion of this area, known as the Ral Ral Division, containing 2,023 acres, of which 1,571 are irrigable land, has been surveyed into blocks. A total of 1,011 acres, including 892 acres of irrigable land, has been allotted to 44 settlers, 37 of whom are soldiers. A pumping plant of 220 b.h.p., with a capacity of 12,500 gallons per minute against a total head of 30 feet has been installed.

The *Irrigation and Reclaimed Swamp Areas* under Government control on the River Murray below Morgan contain 9,890 acres of rateable land, i.e., 852 acres of high irrigable and 9,038 acres of reclaimed swamp land, allotted to 319 settlers, of whom 39 are soldier settlers. The former land is irrigable by pumping, and is devoted to the production of citrus, deciduous and vine fruits; the latter is watered by gravitation and its production is confined to fodder for dairying and sheep raising.

Pumping plants installed total 1,469 b.h.p., with a capacity of 5½ million gallons per hour.

Moblong and Burdett Divisions of the Murray Bridge Irrigation Area, adjoining Murray Bridge, contain 577 acres of irrigable reclaimed fodder land with 45 settlers, of whom one is a soldier.

Long Flat and Monteith Flat below Murray Bridge have between them a reclaimed irrigable area of 1,340 acres, all of which has been allotted to 48 settlers, of whom one is a soldier.

Swanport Area below Murray Bridge has 192 acres of fruit and fodder land, and is allotted to one civilian settler.

The *Jervois Irrigation Area* is situated from 10 miles to 22 miles by river below Murray Bridge and contains 17,413 acres, 3,169 acres being reclaimed swamp. There are 79 settlers on the area, 8 of whom are soldiers. The allotted land comprises 3,147 acres of reclaimed swamp and 13,595 acres of dry land.

The area is divided into four divisions, viz., Woods Point, Jervois, Wellington, and Highland Divisions. The first three consist mostly of reclaimed swamp, and the Highland Division contains dry or "high" land which is allotted to the settlers on the three swamp divisions.

The *Mypolonga Area* is 9 miles above Murray Bridge, and has a river frontage of 7 miles. The total area of this settlement is 5,792 acres, of which 852 are irrigable high land and 1,356 acres irrigable reclaimed land. A rateable area of 2,144 acres has been allotted to 89 settlers, of whom 3 are soldiers.

The *Pompoota Area*, situated 13 miles above Murray Bridge, was previously used as a Training Farm for prospective soldier settlers. The area contains 2,469 acres, of which 385 acres are irrigable reclaimed land. The whole of the rateable area has been allotted to 8 soldier settlers and 5 civilian settlers.

The *Wall Area*, 16 miles above Murray Bridge, has an area of 995 acres, of which 464 acres are rateable reclaimed swamp land. Nine soldiers and two civilians are settled on the area.

The *Neeta Irrigation Area* is 20 miles above Murray Bridge, and contains a total of 2,778 acres, of which 542 acres are rateable reclaimed swamp land. The rateable area of 525 acres has been allotted to 7 civilian and 8 soldier settlers.

The *Cowirra Irrigation Area* is 20 miles above Murray Bridge, and contains a total of 2,368 acres, of which 573 acres are rateable reclaimed swamp land. A rateable area of 484 acres has been allotted to 16 civilian settlers and one soldier settler.

The *Baseby Area* is about 21 miles above Murray Bridge, and has an area of 1,250 acres. This area has been leased to a civilian settler. 528 acres are reclaimed swamp.

The reclaimed lands on the River Murray consist mainly of peaty soils composed of rich river silt, and are eminently suitable for the growth of lucerne and other fodders, onions, potatoes, etc. The soils of the irrigable lands have already proved their suitability for the production of peaches, apricots, nectarines, oranges, lemons, figs, and grapes, etc.

(iv) *Allotment of Irrigated Land.* All lands are allotted under perpetual lease, and blocks are surveyed into areas varying up to 50 acres of high irrigable or reclaimed swamp land. It is not the practice to allot more than 50 acres of irrigable or reclaimed land, or of both irrigable and reclaimed, to any one settler, except that in the case of a partnership 50 acres may be allotted for each member of the partnership up to a maximum of 150 acres.

In addition, areas of non-irrigable land are allotted to lessees of irrigation and reclaimed blocks for dry farming. The rentals of the blocks are fixed by the Irrigation Commission immediately prior to the land being offered for application. For the reclaimed land an amount is charged sufficient to cover interest on cost of the land, the survey thereof, and interest on cost of the levee; while for the irrigable land the rent is based on the unimproved value of Crown lands, or to cover interest on cost of repurchased lands.

On the irrigable land, the present rate is 60s. per acre per annum. On the reclaimed lands an amount is charged to meet the annual management, drainage, maintenance expenses, and certain interest charges, the present rate being 30s. per acre. A sliding scale applies to the rent on all land and water rates on the irrigable land for the first four years, i.e., first year, one-quarter of the full rent and water rates; second year, one-half; third, three-quarters; fourth and afterwards, full amount, per acre. On the irrigable lands each lessee is entitled for the water rates to 24 acre-inches per annum, supplied mostly in four irrigations; special irrigations and domestic supplies are available at a nominal cost at times other than during the general irrigations. On the reclaimed lands, water is supplied as required.

Liberal assistance is provided by the Government to lessees of irrigation blocks. Apart from the erection of pumping plants, construction of main channels and other work necessary to render the land ready for occupation, the Irrigation Commission has power to carry out improvements in the nature of clearing, channelling, fencing, etc. The lessee on allotment is required to take over any expenditure so incurred, and to pay an amount of not less than 15 per cent. of the cost of the work. Subsequent to allotment the Commission has power to expend a sum not exceeding £30 per acre of the irrigable land in any lessee's block in making the following improvements, or any of them:—Fencing, clearing, grading, constructing irrigation channels, drains and tanks thereon, and connecting such channels or drains with the nearest main channel or drain. The lessee is required to pay a deposit before the work is commenced equal to not less than 15 per cent. of the Commission's estimate of the cost of carrying out such improvements. The Commission may also make cash advances to any lessee for all or any of the following purposes:—

- (a) For carrying out improvements and the erection of buildings to the extent of the estimated value of the lease and improvements already made or in course of being made thereon, but not exceeding £650.
- (b) For the purchase of implements, stock, seeds, plants, trees, etc., to any amount not exceeding £200.
- (c) For any other purpose that may be approved by the Commission, but not exceeding three-fourths of the estimated value of the lease and any improvements already made thereon.

The total amount that may be expended or advanced, however, for all or any of the above purposes, including improvements carried out by the Commission, shall not exceed in aggregate the sum of £600, or £30 per acre of the irrigable portion of the land, whichever sum is the greater.

All expenditure incurred by the Commission in improving the land either before or after allotment, or advanced to the lessee to carry out further improvements, must be repaid under the following conditions:—For the period of 5 years following the date on which the land was allotted or advances made, the lessee shall pay interest on the amount at current rates. After the expiration of 5 years, the lessee is required to repay the amount expended or advanced by 70 equal half-yearly instalments, together with interest at current rates on the balance remaining unpaid.

6. *Western Australia.*—In this State an Irrigation Act provides for the constitution of irrigation districts. At Harvey, works for irrigating about 4,000 acres devoted to fruit growing, principally oranges, were opened on the 21st June, 1916.

Numerous small private irrigation schemes are in full operation on many of the south-west rivers, in connexion with fruit, fodder, and potato growing.

7. *Murray Waters.*—(i) *River Murray Agreement.* The River Murray Agreement, with subsequent amendments, entered into by the Governments of the Commonwealth and the States of New South Wales, Victoria, and South Australia, provides for the construction of the following works:—(a) The Hume reservoir, (b) The Lake Victoria storage, (c) Twenty-six weirs and locks in the River Murray, and (d) Nine weirs and locks in the River Murrumbidgee. In the agreement provision is made for these works to be undertaken by the Governments of the three States—the Hume Reservoir and 17 weirs and locks between Echuca and Wentworth, including that at Wentworth, to be constructed by the Governments of New South Wales and Victoria severally or jointly, as may be mutually agreed upon by them; the 9 weirs and locks in the River Murrumbidgee to be constructed by the Government of New South Wales; and the Lake Victoria Storage and 9 weirs and locks in the River Murray below Wentworth by the Government of South Australia

The River Murray Commission, appointed in pursuance of the Agreement referred to, and comprising a representative of each of the four contracting Governments, is charged with the duty of giving effect to the Agreement and the River Murray Waters Acts.

(ii) *Works.* (a) *General.* The works which have been put in hand to date, with the exception of the weir and lock at Blanchetown, which was commenced before the Agreement came into operation, have been or are being constructed in accordance with designs approved by the River Murray Commission.

The following are the works which have been put in hand:—

The Hume Reservoir,	} By the Governments of New South Wales and Victoria.
Weir and Lock No. 26 (Torrumbarry, near Echuca),	
Weir and Lock No. 11 (Mildura),	
Weir and Lock No. 10 (Wentworth), a little below the junction of the Rivers Murray and Darling,	
*Weir and Lock, No. 15, near Euston,	} By the Government of South Australia.
The Lake Victoria Storage,	
Weirs and Locks Nos. 1, 2, 3, 4, 5, 6, 7, and 9.	

* Operations at Weir and Lock No. 15 have been suspended in order that available funds may be utilized for more urgent works.

(b) *The Hume Reservoir.* The site of the Hume Dam, which is being constructed jointly by the Constructing Authorities for New South Wales and Victoria, is located a little below the junction of the Rivers Murray and Mitta Mitta, where the reservoir will receive the run-off from a catchment of 6,000 square miles of mountainous country. The original designs prepared in connexion with this work provided for a reservoir with a capacity of 1,100,000 acre-feet, and the work was put in hand on both sides of the river in accordance with such designs, but with a view to making provision for the greatest possible storage, and in order to enable the reservoir to be utilized for the purpose of hydro-electric generation the four Contracting Governments, acting on expert advice, later agreed to the construction of the dam of dimensions and height sufficient for a capacity of 2,000,000 acre-feet. The cost of the enlarged reservoir is estimated at approximately £6,000,000.

The dam, which is in course of construction, will consist of two main sections—(1) the outlets and flood spillway, and (2) the earthen embankment containing a concrete core wall sunk into the solid granite, and provided with a tunnel for drainage and inspection purposes. The first section, which extends from the New South Wales bank of the river to the Victorian bank, and which will be practically all of concrete, is being constructed by the New South Wales Constructing Authority. The remaining section of the dam, which extends from the Victorian bank of the river to the high ground bordering the river flats, is in course of construction by the Victorian Constructing Authority. The total length of the dam, including both sections above referred to, will be 4,200 feet.

Early in 1929, the gap in the dam on the New South Wales portion of the work was closed, and the outlet and spillway sections raised to a height sufficient to impound 100,000 acre-feet of water. The stored water is at present being discharged through four outlets. On the Victorian side of the river the construction of the earthen embankment and the concrete core wall is considerably advanced. The bridge over the Hume Reservoir in the vicinity of the dam will be completed and open for traffic about August, 1930. The total expenditure incurred to 30th June, 1930, on the whole of the works at the Hume Reservoir amounted to £4,121,000.

(c) *Lake Victoria Storage.* The Lake Victoria Storage is situated in the south-west corner of the State of New South Wales. The scheme approved consists of the construction of extensive embankments and channels, the construction of three regulators (the inlet regulator in the Frenchman's Creek, the controlling regulator in the main inlet channel, and the outlet regulator in the Rufus River), and improvements to Frenchman's Creek and Rufus River.

These works, which are completed, provide for the storage in the lake of 514,000 acre-feet of water for use by the State of South Australia. The expenditure on this work to 30th June, 1930, amounted to £477,185.

(d) *Weirs and Locks.* Nine weirs and locks, viz., No. 10 (Wentworth)—New South Wales—Nos. 11 (Mildura) and 26 (Torrumbarry)—Victoria—and Nos. 1, 2, 3, 4, 5, and 9—South Australia—have been completed, and are now in operation. Preliminary work has been put in hand at No. 7 (South Australia), and No. 6 (South Australia) is practically completed. This weir and lock (No. 6) the last of the works in South Australian territory was officially opened and named the "Simpson Newland" Lock by the Commissioner of Public Works (Hon. M. McIntosh) on the 14th January, 1930.

(iii) *Finance. (a) General.* In the River Murray Agreement of 1914, the estimated total cost of the whole of the works was set down at £4,663,000. Although definite estimates of the cost of those works not yet authorized have not been prepared, it is anticipated that the total ultimate cost of the whole of the works covered by the River Murray Agreement will be in the vicinity of £15,000,000. The total expenditure incurred up to 30th June, 1930, on that portion of the scheme completed and in course of construction amounted to £7,906,500, towards which expenditure the four Contracting Governments in conformity with the amending Agreement previously referred to, have contributed in equal shares.

(b) *Programme of Works to be constructed during the period ending 30th June, 1932.* At a conference of representatives of the four Contracting Governments, it was decided definitely to limit the programme of works to be constructed during the period ending 1932 to the following works, viz.:—The construction of the Hume Reservoir to provide for a capacity of 2,000,000 acre-feet; the completion of the Lake Victoria Storage; and the completion of all Weirs and Locks from No. 1 (Blanchetown) to No. 11 (Mildura) and Weir and Lock No. 15 (Euston). Owing to the general restriction of funds it will not now be possible to complete this programme by the 30th June, 1932.

An amount of £800,000 has been made available by the Loan Council for expenditure on works and land resumption during the financial year 1930–31.

The four Contracting Governments will furnish their respective contributions towards this proposed expenditure as required during the year.

(iv) *Gaugings.* The River Murray Agreement places upon the Commission the duty of carrying on an effective and uniform system of making and recording continuous gaugings of the main stream of the River Murray and its tributaries within the boundaries of each of the States of New South Wales, Victoria, and South Australia, and of all diversions, whether natural or artificial or partly natural and partly artificial, from the main stream and its tributaries. It is further provided that, in lieu of making any such gaugings, the Commission may accept any gaugings made and recorded by any of the Contracting State Governments.

Arrangements have been made with the three Contracting State Governments for the adoption of uniform methods in connexion with all gaugings on the River Murray and its tributaries, and for the submission periodically to the Commission, for purposes of the River Murray Agreement, of the results of such gaugings.

The gaugings made at the Renmark Gauging Station during the year 1928-29 indicated that the total flow of the river at that point was 6,375,340 acre-feet for the year. The total flow at the same station for the preceding year was 5,674,653 acre-feet.

The approximate quantity of water diverted from the river by the three States by artificial or partly artificial means for the same year was 1,842,142 acre-feet.

(v) *River Murray Commission.* The River Murray Commission, as at present constituted, is as follows :—

Commonwealth	..	Senator the Hon. John Barnes (President).
		Deputy Commissioner—Mr. T. Hill, M.V.I.E., M.I.E.Aust.
New South Wales	..	Mr. H. H. Dare, M.E., M. Inst. C.E., M.I.E., Aust.
Victoria	..	.. Mr. R. H. Horsfield, M. Inst. C.E., M.I.E., Aust.
South Australia	..	Mr. J. H. O. Eaton, M. Inst. C.E., M.I.E., Aust.
		Secretary—Mr. D. P. Israel, A.I.C.A., A.A.I.S.
		Accountant—Mr. F. A. Piggin.

More detailed references to the River Murray Agreement and the operations of the Commission will be found in previous issues of the Year Book (see Official Year Book, No. 19, pages 845-850).