

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 herein, viz., in the chapter dealing with Local Government. Interstate Conferences on artesian water were held in 1912, 1914, and 1921, when combined Governmental action was agreed upon with reference to delimitation of the artesian basins, hydrographic surveys, analyses and utilization of artesian water, etc. (See map on page 891.)

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 891) 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 palæozoic rocks of the Mount Lofty and other ranges, extending northwards from near the mouth of the Murray to the Barrier Ranges, 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 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, 1922-23.

Particulars.	N.S.W.	Victoria.	Q'land.	S. Aust. (c)	W. Aust.	Tas. (e)	N. Ter.	Total.
Bores existing .. No.	508	326	2,902	147	198	4	164	4,249
Total depth bored .. feet	849,101	90,000	43,602,072	115,065	179,609	454	53,142	4,890,243
Daily flow ...000 gals.	282,732	b	2299,564	213,204	58,078	46	b	b
Depth at which artesian water was struck—								
Maximum .. feet	4,338	700	6,000	4,850	3,325	90	1,760	6,000
Minimum .. feet	89	150	10	55	39	19	62	10
Temperature of flow—								
Maximum .. °Fahr.	140	b	210	208	140	b	b	210
Minimum .. °Fahr.	72	b	81	82	75	b	b	72

(a) Flowing bores only.

(b) Not available.

(c) Government bores only.

(d) Total depth of

all bores. (e) Sub-artesian bores.

(ii) *New South Wales.*—(a) *Artesian Water Supply.* The New South Wales portion of the great Australian basin, comprising approximately 80,000 square miles, is situated in the north-western portion of the State. Artesian boring in New South Wales dates from 1879, when a private bore was put down on the Kallara pastoral holding, between Bourke and Wilcannia. The first Government bore was that at Goonery, on the Bourke-Wanaaring road, completed in 1884.

The following statement shows the extent of the work successfully carried out by the Government and by private owners up to 30th June, 1923 :—

EXISTING ARTESIAN BORES.—NEW SOUTH WALES, 1923.

Bores.	Flowing.	Pumping.	Total.	Total Depth.
For Public Watering-places, Artesian Wells, etc.	130	36	166	340,641
For Country Towns Water Supply	3	1	4	6,533
For Improvement Leases	27	3	30	47,289
Total Government Bores	160	40	200	394,463
Private Bores	224	84	308	454,638

* See J. W. Gregory, F.R.S., D.Sc. : "The Dead Heart of Australia," London, John Murray, 1906; "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; "The Composition and Porosity of the Intake Beds of the Great Australian Artesian Basin," Sydney, 1915.

The average depth is 1,972 feet in the case of Government bores, and of private bores 1,476 feet, and it ranges from 89 to 4,338 feet. The two deepest wells in New South Wales are those at Boronga, in the County of Stapylton, with a depth of 4,338 feet and a present outflow of 831,180 gallons; and at Dolgelly, in the Parish of Carennga, in County Stapylton, with a depth of 4,086 feet, and a present discharge of 520,010 gallons per day. The largest flow at the present time is that at the Wirrah bore, in the County of Benarba, which yields 1,027,366 gallons a day, and has a depth of 3,578 feet.

Of the 556 bores which have been sunk, 384 are flowing, and give an aggregate discharge of 82,731,703 gallons per day; 124 bores give a pumping supply, the balance of 48 being failures; the total depth bored represents 910,043 feet.

The flow from 77 bores is utilized for supplying water for stock on holdings served in connexion with Bore Water Trusts or Artesian Districts under the Water Act of 1912. The total flow from these bores amounts to 32,790,169 gallons per day, watering an area of 4,496,799 acres by means of 2,768 miles of distributing channels. The average rating by the Bore Trusts to repay the capital cost with 4 per cent. interest in twenty-eight years, is 1.5d. per acre, including the cost of maintenance and administration.

In the majority of cases the remaining bores are used by pastoralists for stock-watering purposes only, but in a few instances the supply is utilized in connexion with country towns.

The watering of the north-western country by means of bore water has largely increased the carrying capacity of the land; and, what is of perhaps greater importance, it has made comparatively small pastoral holdings practicable in country previously confined almost entirely to the operations of companies holding immense areas.

It having been determined that multiplicity of bores is the chief factor governing the annual decrease in bore flows, and also that limiting the discharge from a bore will prolong its flowing life, action has been taken to prevent any waste by controlling the bore flow to actual requirements. It is confidently anticipated that this action will materially reduce the rate of decrease in the future.

(b) *Private Artesian Bores.* Much has been done in the way of artesian boring by private enterprise. As far as can be ascertained, 332 private bores have been undertaken in New South Wales, of which 24 were failures. The yield of the flowing bores is estimated at 37 million gallons per day. No data are available regarding the pumping bores.

(c) *Shallow Boring.* The scheme described in Official Year Book No. 9 (p. 520) for assisting settlers by sinking shallow bores has met with considerable success.

Operations commenced with one plant only, but the number has been increased gradually until 29 plants are at work.

A large number of applications from settlers wishing to take advantage of the liberal conditions offered under the regulations has been received, and further applications are coming to hand daily, consequently the plants now in use will probably be insufficient to cope with the demand. Out of 1,193 bores put in hand up to 30th June, 1923, 209 have proved failures.

There can be no question that the added value of the holdings represented by the bores already put down is considerably in excess of their cost, and as fairly conclusive evidence of this, it might be stated that in several instances the Government Savings Bank has, on completion of a bore, made the settler a sufficient advance to enable him to pay the total cost in cash.

In addition to the work carried out under the Shallow Boring Regulations outlined above, shallow boring plants have sunk 22 bores in the Pilliga scrub and on Crown lands for the Lands and Forestry Departments.

The fact that of the bores put down in the Pilliga scrub, 52 are giving a flowing supply, adds much to their value, and is of special interest as indicating the possibility of tapping a small and hitherto unknown artesian basin.

(iii) *Victoria.* Victoria lies altogether outside the Great Australian Artesian Basin, and as water is generally available from surface or shallow underground supplies, there has not been much occasion for artesian boring. As early as 1880, however, an artesian well

was bored at Sale, which gave a large supply of water of fair quality before it failed through corrosion of the casing. In 1905 a new bore was put down, which at a depth of 277 feet yielded sufficient water to fill Lake Guthridge, a local depression. As the water was, however, impure, and contained an excess of sulphuretted hydrogen, boring operations were continued to 520 feet, when the lowering of the casing shut off the supply of water. A further bore was then put down at some distance from the first, and this, at a depth of 238 feet, yielded a fresh and clear water supply of about 145,000 gallons per day. Corrosion troubles occurred here also, and at the end of 1912 another bore was put down to a depth of 235 feet, artesian flows being struck at 187 feet and 235 feet. Towards the end of 1915 a flow of 200,000 gallons per day was struck at a depth of 125 feet on the Powerscourt Estate, near Maffra. Other bores are being put down in the locality.

Largely due to the failure of surface supplies in the drought of 1878 to 1886, no less than 499 bores were, before the end of 1888, put down by shire councils aided by the Government. The total depth bored was 40,000 feet; fresh water was struck in 78 instances; 47 yielded brackish but usable water; 229 were salt, while the balance were dry. The bores covered practically the whole of the settled portions of Northern and North-western Victoria and parts of Gippsland.

In the late eighties a number of bores were put down in the north-western part of the State, varying from 200 to over 2,000 feet in depth, but without any notable success. In 1897 a Board reported on boring for artesian water supply in the Mallee country, but this report was adverse, except as regards the extreme northern portion thereof. In 1906 eight bores were put down on the Overnewton Estate, Maribyrnong, to depths varying from 147 to 272 feet; small supplies of good and medium water for stock purposes were obtained, but only one of the wells yielded water fit for domestic purposes. In 1908 boring was commenced in the Mallee country near the border east of Pinnaroo in South Australia, and a line of bores from the Border to Kow Plains has proved the existence of a large sheet of underground water. Altogether, 94 bores have been successful in striking fresh water, and their depths vary from 155 to 752 feet, the water rising to within from 207 to 6 feet of the surface. In three instances the bores flow, the water rising from 4 to 17 feet above the surface. The fresh water extends nearly as far east as the 142nd meridian, and its northern limit is approximately the 35th parallel.

At the 30th June, 1923, the number of existing bores in use in the north-western portion of Victoria (Mallee) was 326, from which supplies are obtained by pumping. The total depth bored amounted to 90,600 feet, while the maximum and minimum depths at which water was struck were 700 and 150 feet respectively. The figures include also about 232 existing private bores, with a total depth of about 47,000 feet.

(iv) *Queensland.* A return relating to the 30th June, 1923, classifies the Queensland artesian bores under the following headings:—

ARTESIAN BORES.—QUEENSLAND, 30th JUNE, 1923.

Sunk by—	Artesian Flows.	Sub- Artesian or Pumped Supplies.	In Progress, Abandoned, or Uncertain.	Total.
Government	70	89	144	303
Local governing authorities	16	22	24	62
Private owners	1,201	1,504	976	3,681
Total	1,287	1,615	1,144	4,046

The estimated yield of water from 1,287 flowing bores on 30th June, 1923, was 299,564,420 gallons per diem. The deepest well was about 40 miles west of Blackall, lying east of the Barcoo River; this had a depth of 7,009 feet, and was stated to yield 70,000 gallons daily. Further sinking is in progress. The flow is, of course, a comparatively small

one, many wells yielding, when uncontrolled, from one to three million gallons a day. The waters of many of the wells have been analyzed, and some found suitable for wool-scouring only, others are suitable for watering stock but not for irrigation, owing to the presence of alkali; others again serve for both stock and irrigation, while some, such as those containing sulphuretted hydrogen, are not of any use. Water fit for stock may generally be said to be "safe" for domestic purposes in spite of its slightly mineral taste. The wells yielding the mineral waters known as "Helidon Spa," "Boonah Spa," and "Junot Spa," which are much in use in Queensland and New South Wales, are shallow wells from 60 to 200 feet in depth.

Of the 4,046 bores in Queensland, 365 have been put down by the State Government or Local Authorities, while 3,681 have been sunk by private enterprise; 1,287 bores are flowing, and 1,615 give a pumping supply, the balance of 1,144 are either in progress of construction, or are abandoned, or uncertain. The total depth bored is 3,602,072 feet. The minimum and maximum depths at which artesian water was struck are 10 feet and 6,000 feet respectively, while the temperature of the flow ranged from 81 to 210 degrees Fahr.

Forty-two Bore Water Supply Areas were completed on 30th June, 1923, comprising a total of 3,506,597 acres within the gazetted areas over which water was distributed in 1,592 miles of drains. Eight additional Bore Water Supply Areas were in hand on 30th June, 1923, comprising an area of 961,629 acres, and 437 miles of drains.

(v) *South Australia.*—(a) *General.* There were in South Australia 147 Government bores existing at 30th June, 1923, of which 37 were artesian and 110 sub-artesian. Of these, 108 were under 1,000 feet in depth; 24 from 1,000 to 2,000 feet; 7 from 2,000 to 3,000 feet; 5 from 3,000 to 4,000 feet; and 3 over 4,000 feet. The deepest flowing bore was at Patchawarra, on the Farina to Haddon, via Innamincka route, measuring 5,458 feet, but now yielding only 50 gallons per day. The maximum flow, viz., 1,250,000 gallons, is obtained at Coonie Creek, east of Lake Frome.

The following table gives particulars as to South Australian bores at 30th June, 1923 :—

EXISTING ARTESIAN BORES. (b)—SOUTH AUSTRALIA, 1923.

Particulars.						Artesian and Sub-artesian.
Bores existing	..	..	..	..	..	147
Total depth bored	..	..	..	..	..	115,065
Daily flow	..	..	..	..	gallons	(a) 13,204
Depth at which water was struck—						
Maximum	..	..	..	..	feet	4,850
Minimum	..	..	..	..	feet	55
Temperature of flow—						
Maximum	..	..	..	..	°Fahr.	208
Minimum	..	..	..	..	°Fahr	82
Total cost of construction of bores up to 30th June, 1923	..	..	..	..	..	£330,058
Expenditure during year on boring operations	..	..	..	..	..	£3,447

(a) Flowing bores only.

(b) Government bores only.

Of the above-mentioned bores, 48 are situated within the Great Artesian Basin, and the remainder are in the Lower Murray and other local basins.

(b) *Bores between the Murray and the Eastern Boundary of the State.* The sinking of bores across the Ninety-mile Desert between the Murray and the Victorian boundary was commenced in 1886 at Coonalpyn; with the exception, however, of salt water at 55 feet, no success was met with. Ki Ki bore was sunk in 1887, and at 361 feet a good supply of water fit for stock was struck. Tintinarra bore was sunk in 1887; it was artesian when first tapped. The water was found to be fit for locomotive engines and is

still used for that purpose. The bore at Emu Flat was also sunk in 1887. In 1904 a bore was sunk at Cotton, and numerous successful bores have since been put down by the Public Works Department, and subsequently by residents of the district. The water rises to a distance from the surface of from 15 to 320 feet, and the maximum quantity obtained per diem is 48,000 gallons at the Gosden bore. Several wells, ranging in depth from 55 to 221 feet, have also been sunk in this district. The latest Government bores are Pata bore in the Hundred of Pyap, and Beulah bore in the Hundred of Wilson, at both of which large supplies of water containing $\frac{3}{4}$ oz. of solids per gallon were obtained.

(c) *Bores West of Oodnadatta.* A series of bores has been sunk, beginning with Breaden bore, 20 miles west of Oodnadatta, which was put down in 1911. The others since put down in this district are at Gypsum, Imbitcha, Mirackina, Raspberry Creek, Appreetinna, Wintinna, and Marla. Of these, the only artesian supply is at Raspberry Creek, where 1,000,000 gallons per day of good water are obtained. The depths of these bores range from 280 feet at Mirackina to 1,122 feet at Breaden, and the water from all of them is good. Warranarrea bore situated 72 miles west of Oodnadatta on Pastoral Lease No. 1297 has been completed to a depth of 466 feet, a large supply of good water being obtained.

(d) *Eyre Peninsula.* From time to time bores have been sunk on Eyre Peninsula, but with little success. In some instances, stock water ($1\frac{1}{2}$ oz. salts to the gallon) was obtained, but this occurred only on the Nullarbor plains. In all other cases the water struck was too salt to be used. Consequently the supply of water is now principally from catchments, and a number of reservoirs have been constructed to hold from 1,000,000 to 18,500,000 gallons each, while many underground tanks have been built to contain from 40,000 up to 500,000 gallons each.

(vi) *Western Australia.*—(a) *General.* The work by which the Government of Western Australia provides a permanent supply of water to Kalgoorlie, Boulder, and adjacent districts on the eastern goldfields comes properly under the heading of "Water Supply Works." A description of this undertaking is fully given in previous issues of the Year Book. (See No. 6, p. 576.)

Statistics in connexion with the Goldfields Water Supply undertaking and the Mines Water Supplies will be found in the chapter of this book dealing with *Local Government*.

The following table gives particulars regarding Western Australian artesian bores at 30th June, 1923 :—

EXISTING ARTESIAN BORES.—WESTERN AUSTRALIA, 30th JUNE, 1923.

Particulars.	State.	Private.	Total.
Bores existing	108	90	198
Total depth feet	91,703	88,106	179,809
Daily flow gallons	28,870,260	29,207,900	58,078,160
Depth at which artesian water was struck—			
Maximum feet	2,527	3,325	3,325
Minimum feet	39	70	39
Temperature of flow—			
Maximum °Fahr.	140	(a)	140
Minimum °Fahr.	75	(a)	75

(a) Not available.

To 30th June, 1923, the total number of Government bores was 108, while there were, in addition, approximately 90 private bores recorded.

(b) *The Coastal Plain Basin or Perth Area*, which, generally speaking, extends from Cape Leeuwin to Dongarra, and from which the Metropolitan Water Supply is largely drawn, yields a supply of water mostly fresh and suitable for domestic purposes, though towards the north it becomes brackish and is only suitable for stock.

There are 48 bores in the Metropolitan area, several of which have been put down to augment the hills supply and the domestic supply of the suburbs, and Fremantle is largely dependent upon this source.

(c) *The North-west Basin or Carnarvon Area* may be said to extend from Gantheaume Bay in the south to Onslow in the north, and embraces a very large tract of ideal sheep country.

Many private bores have been put down on sites which permit of the gravitation of the water for miles, and, by this means, a very considerable area has been made available for stock-raising. In all, about 75 bores have been put down.

(d) *The Gulf Basin or Broome Area*. So far very little development work has been done. Artesian bores have been put down in the town site, and the domestic requirements of the town are entirely supplied from this source. The area extends from Condon in the south-west to the Meda River beyond Derby in the north, and for a considerable distance inland. So far only 8 bores have been sunk, 3 being at Broome, 2 at Derby, and 3 on the telegraph line on the road between Derby and Hall's Creek, about 12, 67 and 80 miles inland.

(e) *Eucla Area*. This area extends from Eucla, on the South Australian border, to west of Israelite Bay. So far, beyond the bores put down on the route of the Trans-Australian Railway, very little has been done in proving the resources of this area. In 1902 the first bore was sunk, about 35 miles north of Madura, and sub-artesian water was struck at 430 feet, at an elevation of 400 feet above sea level. Following upon this, a deep bore was put down at Madura, below the cliff and nearer the coast, when an artesian supply of stock water was obtained at a depth of 2,041 feet, yielding 5,700 gallons per day. Later, about 20 bores were sunk along the survey line of the railway, which runs east and west about 90 miles inland. These bores were put in at intervals between the 205 mile peg and the South Australian border, and ranged in depth between 323 and 1,344 feet. In most instances only stock water was struck at depths varying between 300 and 1,300 feet, and the largest supply was estimated at about 10,000 gallons per day.

(vii) *Tasmania*. Sub-artesian bores were recorded for the first time in Tasmania during 1922-23. The number existing at the end of the year was four, giving a supply of 46,000 gallons per diem. The maximum and minimum depths at which water was struck were 90 and 19 feet respectively, and the total depth bored was 454 feet.

(viii) *Northern Territory*. In the Northern Territory, bores to the number of 164 were put down up to 30th June, 1923, which number does not include bores put down by hand-boring plants for test purposes. One bore is artesian, and the others give a pumping supply. The total depth bored in State and private bores was 53,142 feet, and the maximum and minimum depths were 1,760 and 62 feet respectively.

§ 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 settlement 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.

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 small irrigation settlements at Hay and Wentworth; national works of water conservation; shallow boring for settlers; and water trusts and artesian bore trusts operating under the Water Act. The Commission has control also of storages 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 floodwaters, which will be released for use lower down the river 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 and the conditions of tenure, are contained in previous issues of the Year Book. (See Year Book No. 15, page 442.)

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 and vegetable 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, cantaloupes, and citrus fruits, also wine and table grapes, raisins, sultanas, figs, olives, and most varieties of vegetables and fodder crops. Dairying and pig-raising are being undertaken by large numbers of settlers in the areas, and the canning and drying of fruit and the production of wine are becoming industries of large dimensions. The district is already one of the greatest fresh fruit producing centres in the State.

An up-to-date butter factory, which is managed co-operatively by dairymen on the areas, is in operation at Leeton. The output for the year under review was approximately 422 tons, from 280 suppliers. The factory supplies ice to town residents and settlers. A fruit and vegetable canning factory has also been provided, which purchases vegetables and fruits grown by the settlers, and the output is rapidly increasing. Co-operative companies have been successfully floated for the handling of fruit not suitable for canning. Successful pooling schemes have been evolved for the economic handling of fresh fruit. A bacon factory and abattoirs under the same management as the butter factory have been erected at Yanco, where the settlers' pigs are treated, and where stock for butchers is slaughtered for local consumption.

The Department of Agriculture, which controls the Yanco Experiment Farm, has also established at Griffith (Mirrool irrigation area), a viticultural nursery for the propagation of vines on phylloxera resistant stocks. These stocks are intended not only for the supply of settlers on the areas, but for vigneron in all parts of the State.

An electric power station having been erected near Yanco Siding, electric light and power are supplied to the various factories, business people, and residents of Leeton, Griffith and Yanco, and the supply is also available for settlers when the number of applicants in any centre warrants the connexions being made.

On the 30th June, 1923, 2,064 farms were held, representing a total area of 119,609 acres. The number of town blocks held was 839.

In the matter of cultivation, the following particulars indicate the extent of the work performed by the settlers:—There are approximately 8,036 acres under deciduous fruit, 5,033 under citrus fruits, and 5,641 under vines. The estimated population of the areas is about 12,000.

(iii) *Curlwaa Irrigation Area.* The Curlwaa irrigation area is situated on the Murray River near its junction with the Darling River, and comprises 10,600 acres, of which on 30th June, 1923, irrigable holdings consisting of 1,945 acres had been taken up in areas of $1\frac{1}{2}$ to 40 acres, with a leasehold tenure of 30 years, at rentals of from 1s. 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, 7,586 acres were leased as non-irrigable holdings for short terms, in the majority of cases up to five years, with rentals of from 7d. to 5s. per acre, while the remainder of the area is made up of roads, channels, and other reserves. Of the irrigable area, 1,117 acres are planted as orchards and vineyards, of which 868 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 1922–23 was 12,187 cwt., the principal yields being sultanas, 3,588 cwt.; peaches, 2,800 cwt.; and currants, 2,625 cwt. The value of the dried fruit production was estimated at £37,380, while fresh fruit, crops, and other produce of the value of £21,519 were also produced.

Water is pumped from the Murray River by a suction gas plant in 3 units, with a total capacity of 12,500 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 1922–23 the quantity of water supplied was 245,000,000 cubic feet, or 5,624 acre-feet, the average area watered during six irrigations being 1,337 acres. Each lessee is entitled to receive a quantity of water equivalent to a depth of 30 inches per annum.

A section of 525 acres comprising 395 acres of irrigable land has been excised from portion of the area previously held under dry lease, and a contract is in progress for the construction of the channels required to deliver water to 23 blocks, which will be set apart during next financial year.

(iv) *Hay Irrigation Area.* The Hay irrigation area consists of about 4,500 acres, of which on 30th June, 1923, the area held and used for irrigation purposes was 1,035 acres, in 108 blocks of from 3 to 34 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 2,698 acres of non-irrigated land taken up in 48 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 1922–1923 season 172,906,732 cubic feet of water were pumped with nine pumpings. The principal industry is dairying, milk being supplied to the town of Hay, and cream to the local butter factory.

(v) *Projected Irrigation Schemes.*—(a) *General.* The Water Conservation and Irrigation Commission is investigating schemes for utilizing the New South Wales share of the Murray waters, and for storing water for the purpose of irrigation and stock and domestic supply on the Lachlan, 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 also 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 at least 120,000 acre-feet per month at Albury during the irrigating season, and this will permit of a considerable amount of irrigation development along the river.

An investigation is being made into the manner in which the New South Wales proportion of the Murray waters can be most profitably applied, but as yet no conclusion has been reached.

(c) *Lachlan River.* The construction of a storage reservoir at Wyangala, below the confluence of the Abercrombie River, is being investigated with the intention of providing water in the river channel for pastoral purposes and for the irrigation of limited areas along the river banks. A proposal is also being investigated for the increase of the storage in Lake Cudgellico, which is fed from the Lachlan River, portion of the stored water being released in the summer months to supplement the flow of the river when necessary. The possibility of constructing a series of low weirs between the towns of Cowra and Booligal is also receiving consideration.

(d) *Macquarie River.* The construction of a storage reservoir on the river at Burrundong, below the confluence of the Cudgegong River, for the purpose of affording water for irrigation and stock and domestic supply below Wellington is now being investigated. Smaller schemes for the construction of storage dams at White Rock and on Campbell's River, at Bathurst, have also received consideration. Systematic gaugings are being made of the river flow with a view to determining the quantity of water which will be available if the storage dam be constructed.

(e) *Hunter, Namoi, and Peel Rivers.* Pumping by licensed private irrigators under the Water Act 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 to adequately 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 on the Namoi River above Manilla, and lower down above the junction of the Peel River at alternate sites.

(vi) *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 owners.

During the year ending 30th June, 1923, 226 applications were received for fresh licences, comprising 181 in respect of pumps, or pumps in conjunction with dams or other works, 23 in regard to dams, and 22 other works. The number of applications received for the renewal of existing licences was 127; 77 of the applications were in respect of pumps, in some cases used in conjunction with dams or other works, 46 respecting dams, and 4 races and other works. Approximately 1,573 licences were in force on the 30th June, 1922, and in the succeeding twelve months 139 new licences were issued and 16 were allowed to lapse, so that there were about 1,696 licences current on the 30th June, 1923.

(vii) *Water Trusts and Bore Trusts.* Part III. of the Water Act 1912 provides for the supply of water either for irrigation, stock, or domestic purposes, or for drainage. The liabilities thereon are repaid to the Crown, with interest spread over a period of usually 21 or 28 years, and the works are administered by trustees appointed from among the beneficiaries under the Act, except in the case of trusts in the Western Division, where the Western Land Board is appointed as trustee. For the supply of

water, trusts have been constituted in connexion with (a) seventy-nine artesian wells; (b) nine schemes for the improvement of natural off-takes of effluent channels, for the purpose of diverting supplies from the main rivers; (c) in four instances for the construction of weirs across stream channels; (d) three pumping schemes, two from natural water-courses, and one from a well; and (e) one for impounding by means of regulators water which flows into natural lakes. The total area included within these trusts amounts to 7,814,657 acres.

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 and Water Supply 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 1915.

(ii) *Irrigation Schemes.* (a) *General.* This division comprises the schemes constructed and under construction for the supply of water to some twenty-four irrigation districts. Up to 1906 these schemes were controlled by local Trusts, which had obtained the moneys for their construction on loan from the State. By the Water Act 1905 all local control was abolished except in the case of Mildura, and the districts were transferred to the State Rivers and Water Supply Commission. Since that date the Government has adopted a vigorous irrigation policy, and the capital expenditure at 30th June, 1923, on water supply in the irrigation and water supply districts under the control of the Commission and at Mildura, exclusive of the amount £673,000 expended by it on River Murray Agreement Works, was £6,374,000. 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 £1,126,000, is not debited to any particular districts, but is borne by the State. The extent of land under irrigated culture last year for all kinds of crop was 350,727 acres, being an increase of 62,820 acres over the area irrigated in the previous year, and 44,765 acres above the average of the last four years.

(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 400,000 acre-feet. The completion of works under construction will increase this to 654,000 acre-feet, and this, added to 300,000 acre-feet divertible direct from the river, brings the total artificial supply to 954,000 acre-feet.

The Goulburn Scheme was inaugurated by the construction of the diversion work known as the Goulburn Weir, near Nagambie, which was commenced in the year 1887 and completed in 1891. It is built of concrete masonry, backed with coursed granite blocks. It is 695 feet in length over the abutments, exclusive of the space occupied by the channel regulators—a further 230 feet—or 925 feet in all, and 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. The weir is provided with 21 flood-gates of wrought and cast iron, each gate being 20 feet by 10 feet and weighing 7 tons. To provide a clear waterway for the discharge of floods these gates are lowered into recesses in the body of the structure

* Cusecs = Cubic feet per second.

during high stages of the river flow. The gates are raised and lowered by means of screw-gearing operated by three turbines, the motive power being derived from the river water.

The water is diverted by two main channels, the eastern carrying 660 acre-feet per day a distance of 32 miles to the Shepparton Irrigation District, north of the Broken River, while the western channel, with a capacity of 3,434 acre-feet per day, and a length of 23 miles, supplies the eastern half of the Rodney main channels, and fills Waranga Reservoir, the present principal storage basin of the scheme.

Waranga Reservoir has been formed out of a natural depression 6,000 acres in extent and some 6 feet deep. The construction of an earthen embankment $4\frac{1}{2}$ miles long formed a reservoir covering about 19 square miles to a mean depth of nearly 21 feet. This work was commenced in the dry year 1902 and completed in 1905 to a capacity of 201,300 acre feet. The progress of closer settlement and the increasing demand for water led to the enlargement of the embankment so as to raise the water level 10 feet. This work, recently completed, increases the length of the embankment to $4\frac{1}{2}$ miles, the submerged area to 23 square miles, and the storage capacity to 333,400 acre-feet.

Two main channels issue from this reservoir—the Waranga-Rodney—capacity 500 acre feet per day, which feeds the western half of the Rodney Main Channels, and the Waranga Western Main Channel—92 miles in length—which leaves the reservoir with a capacity of 2,000 acre feet per day, crosses the Campaspe River as a reinforced concrete syphon, and reduces to 400 acre feet per day at the Serpentine Creek—the present termination. This channel is being extended to the west side of the Loddon—98 miles westward from the reservoir.

In view of the continually increasing demand for water in dry seasons, and the repeated requests for extensions of the system, the Commission had investigations made to determine the most suitable site for an additional storage reservoir. After a number of sites had been examined as to foundations, probable storage capacity, and estimated cost, the Commission adopted what is known as the Sugarloaf site, just below the junction of the Goulburn and Delatite Rivers, as the most economical. The first section of the dam, which will be carried to a height of 135 feet above the river bed, has its foundation in places 75 feet below the natural surface. This section will have an over-all length of 3,000 feet, of which 2,300 feet will 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 first section of the work will submerge an area of 7,600 acres and permit the storage of 300,000 acre-feet of water, of which about 60,000 can now be impounded, and the design provides that the dam may ultimately be carried to a height of 190 feet from the river bed. The dam so raised would submerge 16,200 acres and impound 918,000 acre-feet. The catchment area above this reservoir is 1,500 square miles. The storing of water was commenced in 1922.

The portion of the State at present served by the Goulburn system comprises 21,000 acres east of the river, 565,000 acres between the Goulburn and the Campaspe, and 284,000 acres between the Campaspe and the Loddon. These areas include the irrigated closer settlements at 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 150 miles, in addition to which there are 1,650 miles of distributaries, a total for the whole system of 1,800 miles.

The balance of the area, including Deakin District, 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" is at present 7s. per acre-foot in the two districts—Tragowel Plains and Dingee—farthest removed from the sources of supply, and 6s. per acre foot elsewhere.

Following strong demands for the extension of existing districts and the provision of an irrigation supply for new areas, the Commission is having the eastern main channel enlarged for its whole length, and extended to command large areas of land north of Shepparton District, and to serve also the suitable lands commanded south of the Broken River. The Waranga western main channel is being extended to the west side of the

Loddon, to improve the supply to Boort District; and a new channel, from the Waranga main channel near Tandarra, through Calivil, to the No. 1 main of Tragowel Plains district, is already under construction. These works will have the effect of strengthening existing supplies, and of bringing large areas of new irrigable land under irrigation.

(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 340,000 acres, served by 1,000 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 drop 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 Cobuna, Gannawarra, Koondrook and Swan Hill, comprising in all 150,000 acres on the river frontage (hitherto dependent on pumping plants during low stages of river flow), and the Kerang districts and adjacent areas, containing about 100,000 acres, more distant from the river, and 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 one acre-foot per irrigable acre. The compulsory charge is at present 6s. per acre-foot of such water right in Swan Hill district, and 7s. per acre-foot in the other three districts. In Kerang district—not yet under a compulsory irrigation charge—water is sold to irrigators on application at a charge not exceeding 3s. per acre foot of water supplied. In the Swan Hill district 3,800 acres of irrigable land were specially purchased for soldier settlement, and subdivided into 121 holdings. The channel system has been correspondingly extended.

In addition to improving the supplies to existing irrigation districts, the Torrumbarry weir will enable large areas adjacent to these districts to be commanded by extensions of existing channel systems.

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 Water Acts.

The site of the dam, which is on the Upper Murray, just below the junction of the Mitta River, and 6 miles due east of Albury, was adopted as being the one most suitable, having regard to foundations, storage capacity, cost of construction, and of lands to be submerged.

The reservoir will receive the run-off from a catchment of 6,000 square miles of mountain range country comprising the whole of the Mitta watershed area of 1,650 square miles, and 4,350 square miles of the area drained by the Murray and its tributaries above the Mitta Junction. The original design provides for a storage capacity of 1,100,000 acre-feet, i.e., the quantity required to cover 1,100,000 acres to a depth of one foot; but later investigations show that it will be practicable to increase the capacity to 2,000,000 acre-feet should the need arise. The stored water will be backed up along the Murray Valley for a distance of about 32 miles, covering an area of 16,820 acres, and along the Mitta for 17 miles, submerging 13,480 acres, and will thus form a lake having a surface area of 30,500 acres or 47 square miles. These figures can best be appreciated by comparison with some well-known standard. For instance, the surface area of Sydney Harbour is 17 square miles, so that the Hume Reservoir, when full, will have a water spread $2\frac{1}{2}$ times as large as Sydney Harbour, and second to no other artificial sheet of fresh water in Australia.

The dam is being constructed in three sections:—(1) Earthen embankment, 2,700 feet in length, with a concrete core for the full height. (2) Concrete spillway, including turbine wells, 740 feet in length. (3) Outlet works, 161 feet, making a total length of 3,601 feet.

The earthen embankment will be on the Victorian side of the river. The crest will be 85 feet above the river flats, and 12 feet clear above the full supply level of the reservoir. The width of the crest will be 32 feet, which includes provision for a roadway.

The concrete spillway will be built in the river channel. The crest will be 79 feet above the bed of the river, and will be surmounted by flood gates 15 feet high, to work between piers which will support the roadway. The motive power for operating the gates will be derived from the river water. The spillway has been designed to discharge over 100,000 cusecs, or 200,000 acre-feet per day.

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 recently established Red Cliffs Soldier Settlement.

The Tresco District of 4,000 acres, created by private enterprise, and recently 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 $2\frac{1}{2}$ 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 46 miles. The settlement contains 3,800 acres, subdivided into 208 holdings of an average area of 17 acres—practically all settled. The settlers include 60 discharged soldiers. Water rights are apportioned to these holdings on the basis of $2\frac{1}{2}$ 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 8,300 acres, originally Crown lands. This settlement now contains 384 holdings, averaging 21 acres each, all of which are settled, the settlers including 166 discharged soldiers. The water is obtained from the Murray by pumps, which deliver 244 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 Red Cliffs Irrigation Settlement comprises 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, when completed, will rank 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, an electric generator of about 350 k.w. capacity, to provide for re-lifts and a system of main and distributary channels to command every holding in the district. Two pumping units out of three have already been installed and are in operation. The third is under construction. The total length of channels constructed to date is 104 miles, the excavation involved totalling 620,000 cubic yards. Some 700 discharged soldiers have been allotted blocks on this settlement.

(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 160 miles of channels in the Boort district, which supply an area of 74,000 acres for domestic and stock purposes and partial irrigation.

(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 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, 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 for the dam—a large cyclopean concrete structure—provides for the raising of water to a maximum height of 100 feet above the foundations. The capacity of the storage will be 150,000 acre-feet, while the unregulated flow of the river will yield an additional 100,000 acre-feet. The construction of the works is well advanced, and it is expected that the settlers on the Boisdale Closer Settlement portion of the district will be supplied with water during the coming year. The commanded lands are specially suitable for beet culture and dairying, and include some 10,000 acres acquired by the State Rivers and Water Supply Commission for soldier settlement. 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, 1923, was £6,090,000. The area of country lands artificially supplied with water for these purposes is nearly 21,300 square miles. The number of towns supplied, exclusive of the City of Melbourne and its suburbs, is 175, serving an estimated population of 339,000. 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 favorably, 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

four reservoirs in the catchment area of the Wimmera River, at the foot of the Grampians Ranges, viz.:—Lake Lonsdale, Wartook, Fyans Lake, and Taylor's Lake. The reservoirs in use, including some minor works, have a combined storage capacity of 148,000 acre-feet. The completion of the works in progress will bring this total to 210,000 acre-feet. The water is conveyed partly by natural water-courses but chiefly by artificial channels aggregating over 4,500 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).

(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 district, by means of bores and large public tanks. The number of successful Government bores in use in this area is 94, their average depth being 420 feet. There are also 176 tanks, having a total capacity of 950,800 cubic yards, or 160 million gallons.

(d) *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 is being opened up for settlement by this water supply scheme, and the construction of 51 miles of railway from Red Cliffs westward toward South Australia. The water for this extensive area will be drawn from the River Murray. The scheme comprises two main lifts, of about 125 and 150 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 200,000 acres have already been allotted to settlers, and, for the service of this area, 210 miles of channels have been excavated, and 14 earthen storages, with a combined capacity of 250,000 cubic yards, have been constructed at convenient distances from railway stations. The first unit of the pumping scheme and the rising main being near completion, water will be turned into the channels and storages early in 1924. The construction of the remaining works of the scheme will precede the throwing open of additional lands for settlement.

(e) *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 22,500 acre-feet, and "Malmsbury" with a capacity of 12,300 acre-feet, together with main and distributary channels aggregating 330 miles in length, 23 subsidiary reservoirs, 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 some 235,000 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 6,000 acres.

(f) *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, and for the service of fifteen townships *en route*, including Berwick, Beaconsfield, Pakenham, Aspendale, Chelsea, Carrum, Frankston, Mornington, and Hastings. 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 works are so far advanced that water is already being delivered at the Naval Base, and to the townships of Mornington, Frankston, Carrum, Aspendale, and the intervening bayside resorts, as well as the inland townships of Beaconsfield, Berwick, Cranbourne, Somerville, and Bittern.

The scheme is being extended to supplement the supply to the township of Dandenong, hitherto controlled by a local Trust, the works of which were recently transferred to the Commission, which will administer them as part of the general scheme.

(g) *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 88,500 acre-feet of water. This system serves, for domestic and stock purposes, an area of 40,000 acres, constituted the "Kerang North-West Lakes Waterworks District." The lakes are filled by gravitation from the Torrumberry 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, limited quantities of water are 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 strong demand, an Irrigation District of 18,000 acres ("Mystic Park") has been constituted on the west of the Lakes, and works are in course of construction to provide an irrigation supply to some 9,000 acres on the east.

(h) *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.

(i) *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 town of Wonthaggi, a service reservoir—capacity 1,400,000 gallons, and 18 miles of pipe reticulation for the service of that town. The population supplied is 5,000, in addition 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 is carrying out extensive schemes at Koo-wee-rup and Cardinia, in the south-eastern portion of the State, and works on a smaller scale at 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. They 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.

(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 13,000 acres are under intense culture, vines predominating. During the year ending 30th June, 1923, the Trust's receipts aggregated £54,217, and its expenditure £48,846, whilst loans—exclusive of £7,510, arrears of interest—advanced by the Government amounted at 30th June, 1923, to £95,893. The number of water acres supplied during the year was 42,807.

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

(i) *Dawson Valley Scheme.* The Dawson Valley Irrigation Scheme, now under construction, 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 27 miles down stream for the diversion of water for the irrigation of 200,000 acres in the Dawson Valley.

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 water level at the site, and the crest height at 140 feet, with a spillway on the right 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.

The main canal is being given a fall of 1 foot per mile, and water for irrigation purposes can be diverted from it shortly after leaving the regulating weir. A model garden town has been laid out on the banks of the river.

The irrigable lands are of a good agricultural type, suitable for irrigation, with good capillarity, ample humus, and containing liberal amounts of all mineral plant foods in ready 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 will utilize the water power to irrigate 50,000 acres of high level lands situated above the river flats, and not commanded by gravitation.

The Dawson Valley Works are situated in the central division of the State. The area of the latter is 209,340 square miles, and the population, as derived from the 1921 census, 88,945. Since then, agriculture has increased on account of cotton cultivation proving successful, and in 1922 a third of the State's crop came from the Dawson Valley.

A railway line is in course of construction through the irrigation areas from the present terminus of the Dawson Valley Line at Baralaba.

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.

(ii) *Inkerman Irrigation Area.* This area is situated at Home Hill, Ayr district, using the waters of the Burdekin River, with electrically operated shallow well pumps. The number of wells and pumps is 230, and the acreage under irrigation at the end of 1923 was 4,500. Provision is being made to increase this area to 10,000 acres.

(iii) *Other Schemes.* Smaller schemes include Townsville (wells, creek, and river); Rockhampton (wells, river, creek, &c.); 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.

(iv) *Extent of Irrigation.* There were 858 irrigators in the State in 1922, chiefly farmers and graziers, and the area irrigated was 14,314 acres.

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 30,000 acres, and the irrigated area 7,850 acres. The population of the town and settlement is 4,800. Sultanas, currants, doradillas, gordos, oranges, apricots, peaches, pears, prunes, olive oil, and grape spirit are the chief products. There are two distilleries for the manufacture of grape spirit and several packing sheds for dried fruits. The dried fruit pack for 1923 amounted to 2,750 tons, consisting of currants, 1,000 tons; sultanas, 975 tons; lexias, 520 tons; apricots, 175 tons; peaches, 50 tons; and pears 30 tons.

(ii) *Other Waterworks.* A number of country water works are 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 the 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 February, 1924, contained 17,827 acres of irrigable land, allotted to 1,068 settlers, including 587 returned soldiers, and 11,264 acres ready for allotment. The pumping plants at present installed or being installed on these areas aggregate 8,050 brake horse-power, with a pumping capacity of 12 million gallons per hour.

The *Cadell Irrigation Area* is 7 miles by river above Morgan, and comprises 2,726 acres, of which 1,183 are irrigable. Blocks have been allotted to 77 soldier settlers and 4 civilian settlers, and the balance is ready for allotment in 4 blocks. 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 90 feet. This area was first allotted on 30th September, 1919.

The *Waikerie Irrigation Area* is 39 miles above Morgan by river, and includes the old Waikerie and Ramco settlements. The total area is 9,300 acres, of which 3,103 acres is first class irrigable land, growing fruit trees and vines. The area allotted is divided between 183 settlers, the first allotment taking place on 5th July, 1910. The pumping plant consists of five units, four suction gas and one steam unit, with a total of 1,440 b.h.p. The capacity of the plant is 17,700 gallons per minute against a total head of 150 feet.

The *Holder Irrigation Area* adjoins the Waikerie Irrigation Area, and has been incorporated as a portion of that area. It contains 471 acres of irrigable land, and 1,890 acres of dry land. Blocks have been allotted to 19 settlers, including 9 soldier settlers, and a further 3 settlers can be accommodated. An area of 115 acres of the irrigable land has been subdivided into 42 small allotments. The pumping plant consists of two steam units, with a total of 338 b.h.p., and a capacity of 3,750 gallons per minute. An adjoining irrigable area of 110 acres, held by Holder Ltd., is irrigated by this plant.

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 3,748 acres, of which 493 acres are irrigable. This area was allotted to 30 settlers in July, 1914, and is used for fruit and vine culture. The water is pumped by a 118 b.h.p. steam plant with a capacity of 2,000 gallons per minute against a total head of 118 feet.

The *Moorook Irrigation Area*, adjoining the Kingston Area, contains 5,960 acres of land, of which 1,049 acres is good land suitable for vines and fruit culture. Altogether 961 acres of irrigable land have been allotted to 52 settlers, of whom 31 are soldier settlers. The first allotment 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 142 feet.

The *Cobdogla Irrigation Area* is on the opposite side of the river to Kingston and Moorook Areas. It was formerly a sheep station, and was resumed by the Government for irrigation purposes. The total area of the station was 160,000 acres, of which 23,400 acres had 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, and is filled at high rivers by Chambers Creek. The water is retained in the lake by a weir with movable shutters, erected at the junction of the lake and creek.

The Cobdogla Area contains about 30,000 acres of first class land capable of intense culture. The area is divided into 5 divisions, viz., the Cobdogla, Nookamka, Loveday, McIntosh, and Weigall divisions.

The Cobdogla division has been developed as a low-lift area, the pumping head being about 40 feet, to irrigate 1,836 acres of land, suitable for vine and fodder growing. An area of 671 acres has been allotted to 20 settlers, and 1,133 acres are ready for allotment.

The Nookamka division, south of Lake Bonney, has an irrigable area of 2,604 acres, of which 1,976 acres have been allotted to 119 soldier and 9 civilian settlers, 64 acres are reserved as a nursery, while the balance is ready for allotment. The first allotment took place on 16th March, 1922.

The Loveday division has an irrigable area of 8,800 acres, divided into 570 blocks. The construction work on this area has been completed, and 34 blocks have been allotted to soldier settlers. The reticulation is by means of pipe lines, for both main and branches, instead of open channels. The pipes are of reinforced concrete, and the work has been carried out by the Hume Pipe Co. (Australia) Ltd.

Pumping plants have been installed on the Cobdogla, Nookamka, and Loveday divisions. On the Cobdogla division a 340 b.h.p. steam plant with a capacity of 18,700 gallons per minute has been installed. Two "Humphrey" gas pumps are in course of installation with a combined capacity of 47,600 gallons per minute. The Nookamka division has two steam units, totalling 650 b.h.p., with a capacity of 13,000 gallons per minute. The Loveday division has a 275 b.h.p. plant, with a capacity of 6,000 gallons per minute; two other units are being installed of 1,315 b.h.p., with a total pumping power of 33,300 gallons per minute.

The *Berri Irrigation Area* is 120 miles above Morgan by river, and contains a total area of 23,400 acres, of which 8,100 acres is first class land for fruit and vine culture. A total of 7,671 acres of irrigable land has been allotted to 463 settlers, of whom 270 are soldier settlers, and 342 acres are ready for allotment in 28 blocks. 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, at present known as Ral Ral. Preliminary survey work has been carried out over 14,000 acres of prospective irrigable land. A portion of this area, 1,760 acres, has been subdivided into 114 blocks, 58 of which have been allotted to settlers, 47 being soldier settlers. A pumping plant with a capacity of 12,500 gallons per minute against a total head of 50 feet has been installed.

The *Irrigation and Reclaimed Swamp Areas* under Government control on the River Murray below Morgan contain 5,800 acres of high, irrigable, and reclaimed swamp land allotted to 241 settlers, of whom 56 are discharged soldiers. The former land is irrigable by pumping, and the latter by gravitation. There are also 7,900 acres ready for allotment or in course of preparation, which will accommodate 360 additional settlers. Pumping plants installed total 2,000 b.h.p., with a capacity of 5 million gallons per hour.

Moblong and Burdett Areas adjoin Murray Bridge, and contain 575 acres of reclaimed fodder land with 47 settlers.

Long Flat and Monteith Flat below Murray Bridge have between them a reclaimed area of 1,342 acres, divided between 57 settlers.

Swanport Area below Murray Bridge has 191 acres of fruit and fodder land, and has 4 soldier settlers.

The *Jervois Irrigation Area* is in course of construction. It is 15 miles below Murray Bridge, and includes 1,370 acres of irrigable and reclaimed land, which will accommodate 44 settlers when completed.

The *Woods Point Area* is 12 miles below Murray Bridge, and contains in its total area of 3,726 acres about 1,090 acres of reclaimed land. The area is in course of preparation, and will accommodate 49 settlers.

The *Wellington Area* is 18 miles below Murray Bridge, and has an area of over 12,000 acres; of this area about 1,627 acres are reclaimed land. Provision is made for 67 settlers, and the land is at present in course of preparation for settlement.

The *Mypolonga Area* is 9 miles above Murray Bridge, and has a river frontage of 7 miles. The total area of this settlement is 5,800 acres, of which 1,036 are irrigable, and 1,627 acres reclaimed land. The settlers thereon number 84.

The *Pompoota Area* is situated 13 miles above Murray Bridge, and was previously used as a Training Farm for prospective soldier settlers. The area contains 4,127 acres, of which 670 acres are fruit and fodder land. Blocks have been allotted to 24 soldier settlers, and a further 7 settlers can be accommodated.

The *Wall Area*, 16 miles above Murray Bridge, has 768 acres of irrigable and reclaimed land. Twelve soldier settlers are settled on the area, and blocks are available for 15 more.

The *Neeta and Cowirra Irrigation Areas* are 20 miles above Murray Bridge, and include 422 acres of high irrigable land, and 1,621 acres of reclaimed fodder land. These areas are ready for allotment. At present 13 soldier settlers have been placed on the blocks, and a further 87 settlers can be accommodated.

The *Baseby Area* is about 21 miles above Murray Bridge, and has an area of 1,350 acres, of which 528 acres will be reclaimed and allotted to 26 settlers. Development work is proceeding on this area.

The reclaimed lands consist 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.

(iv) *Allotment of Irrigated Land.* All lands are allotted under perpetual lease, and blocks are surveyed into areas varying up to 50 acres of irrigable or reclaimed land. No lessee is permitted to hold more than 50 acres of irrigable or reclaimed land, or of both irrigable and reclaimed, 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 and reclamation, 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.

The water rates are fixed from year to year. 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, and maintenance expenses. A sliding scale covers 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 rent and water rates; second year, one-half; third, three-quarters; fourth and afterwards, full amount, per acre. This sliding scale is subject to variation in the case of blocks which are wholly or partially planted at time of allotment. On the irrigable lands, each lessee is entitled for the water rates to 24 acre-inches per annum, supplied in four irrigations; special irrigations and domestic supplies are supplied at times other than during the general irrigation at a nominal cost. On the reclaimed lands, water is supplied regularly by reticulation from the river.

The Commission assists settlers by fencing, clearing, grading, and constructing irrigation channels and tanks; but before the work is commenced a deposit must be paid equal to 15 per cent. of the Commission's estimated value of such improvements. It may also make cash advances to the lessee of any block for effecting further improvements, in accordance with the conditions of the Irrigation Act 1922.

The total amount of money expended or advanced by the Irrigation Commission in respect to any one piece of land shall not exceed the sum of £600, or £30 per acre of the irrigable portion of the land, whichever is the greater.

The money so expended or advanced shall remain as a mortgage loan on the land, repayable with current rate of interest per annum in 70 equal half-yearly instalments after the expiration of five years, or at such shorter period as the lessee may desire. During the first five years interest only at the current rate per annum would be payable on the total amount of the advance.

Any lessee is permitted to accept the contract for carrying out his own improvements according to the specifications and estimates of the Commission, up to the maximum amount per acre, as mentioned above.

Blocks of land offered to soldier settlers have in most instances been prepared for settlement by the construction of channels and drains, clearing, grading, partially planting, and fencing by the Irrigation Commission.

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. A scheme is now in preparation for irrigating a further area in the same district.

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, entered into by the Governments of the Commonwealth and the States of New South Wales, Victoria, and South Australia in 1914, and which was brought into operation by proclamation on 31st January, 1917, provides for the construction of the following works :—

The Hume Reservoir,

The Lake Victoria Storage,

26 Weirs and Locks in the River Murray between Echuca and Blanchetown, and

9 Weirs and Locks in the River Murrumbidgee, or, alternatively, at the discretion of the Government of New South Wales, in the River Darling.

(The Government of New South Wales decided in favour of the construction of these weirs and locks in the River Murrumbidgee.)

The Agreement provides that the construction of these works shall be undertaken by the Governments of the three States. The Hume Reservoir and 17 weirs and locks between Echuca and 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 nine 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 Governments named, is charged with the duty of giving effect to the Agreement and the River Murray Waters Acts.

The Agreement directs that the Governments of the three States shall submit to the Commission a general scheme of the works to be undertaken by them respectively; and, further, that before the commencement of any particular work designs and estimates in relation thereto shall be forwarded to the Commission for approval by that body.

(ii) *Amendment of the Agreement.* As a result of proposals placed before the Conferences of Premiers which met on 25th May and 20th July, 1920, and the discussions which took place thereon, an agreement, providing for the amendment of the River Murray Agreement of 1914, was entered into by the four Contracting Governments on 23rd November, 1920. In the Agreement as so amended it was proposed that the construction of all works covered by the River Murray Scheme should be placed under the control of the River Murray Commission in lieu of the three Constructing Authorities as provided for in the Agreement of 1914. It was also provided that the four Contracting Governments should contribute towards the cost of the scheme in equal shares, and that all plant required for the construction of works should be purchased by the Commission from funds provided by the four Contracting Governments. The Parliaments of the Commonwealth and the States of Victoria and South Australia passed legislation giving effect to the amendments proposed. As the Parliament of New South Wales did not, however, pass the Agreement in the terms approved by the four Contracting Governments, the amending Agreement in question was not ratified.

Following upon a Conference of Ministers representing the four Contracting Governments in May, 1923, an agreement was entered into by the four Governments providing for the variation of the 1914 Agreement, as follows :—

- (1) The Weir and Lock at Wentworth, one of the 17 weirs and locks set down in the 1914 Agreement for construction between Echuca and Wentworth, to be constructed by the Governments of New South Wales and Victoria at a site below the junction of the Rivers Murray and Darling.
- (2) The construction of works which will provide for the needs of irrigation to have precedence over the construction of any works which will be primarily for the requirements of navigation.
- (3) All tolls collected at the various weirs and locks to be distributed in equal proportions among the three Contracting States.
- (4) The period of seven years referred to in Clause 44 of the Agreement relating to the distribution of waters following upon the completion of the Upper Murray Storage to be extended to twelve years; the amount of water to be allowed to pass for supply to South Australia in the meantime to be determined by a three-fourths majority of the River Murray Commission.
- (5) The Commonwealth Government's contribution towards the cost of the works covered by the River Murray Agreement to be increased from £1,000,000 to a quarter share, upon the understanding that it is the intention to carry out the original agreement subject to any modifications thereof as are at any time mutually agreed upon by all the Contracting Governments.

This amending Agreement was subsequently ratified by the four Parliaments concerned, and came into operation as from the 16th November, 1924.

(iii) *Works.* The whole of 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, and which was in that Agreement specifically exempted from the provisions thereof, have been constructed, 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 at 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,	
The Lake Victoria Storage,	} By the Government of South Australia.
Weirs and Locks Nos. 1, 2, 3, 5, 9,	

Of the above works the weir and lock at Blanchetown (No. 1) and that at Torrumbarry have been completed and brought into operation.

The site of the Hume Reservoir, which has been designed to provide for a capacity of 1,100,000 acre-feet, is located a little below the junction of the Rivers Murray and Mitta Mitta. The work is being carried out by the Constructing Authorities in the States of New South Wales and Victoria. On the New South Wales section of the work considerable progress has been made in connexion with the excavations for foundations for the concrete structure, and with the construction of the concrete wing walls. The construction of the concrete core wall and the earthen embankment on the Victorian side of the river is proceeding steadily.

The Lake Victoria Storage is situated in the south-west corner of the State of New South Wales. The scheme approved for the provision of a storage at Lake Victoria consists of the construction of extensive embankments and channels, and inlets and outlet regulators. These works are now approaching completion. The storage when completed will have a capacity of 514,000 acre-feet.

(iv) *Finance.* In the River Murray Agreement of 1914 the estimated total cost of the whole of the works was set down at £4,663,000, and it was provided that the four Contracting Governments contribute towards such estimated expenditure in the following proportions, viz. :—

Commonwealth	..	..	..	£1,000,000
New South Wales	..	..	..	1,221,000
Victoria	..	..	..	1,221,000
South Australia	..	..	..	1,221,000
				<hr/>
				£4,663,000

It is now clear, from the experience which has been gained in connexion with the works which have been put in hand to date, that the total cost of the whole of the works will be considerably in excess of the estimate referred to. The total expenditure incurred up to 31st December, 1923, on that portion of the scheme completed and in course of construction amounted to £2,333,000, towards which expenditure the four Contracting Governments, in conformity with the amending Agreement previously referred to, have contributed in equal shares.

The Commission's estimate of expenditure during the current year forwarded to the four Contracting Governments, in accordance with the requirements of Clause 34 of of the River Murray Agreement, amounted to £1,039,000. The total expenditure incurred during the first half of the year amounted to £314,154.

The Commission's estimate of expenditure in respect of the year 1924-25 is as follows :—

New South Wales—

Hume Reservoir	..	..	..	£300,000
Weir and Lock No. 10 (Wentworth)	..	..	..	80,000
Surveys and Borings	..	..	..	10,000
				<hr/>
				£390,000

Victoria—

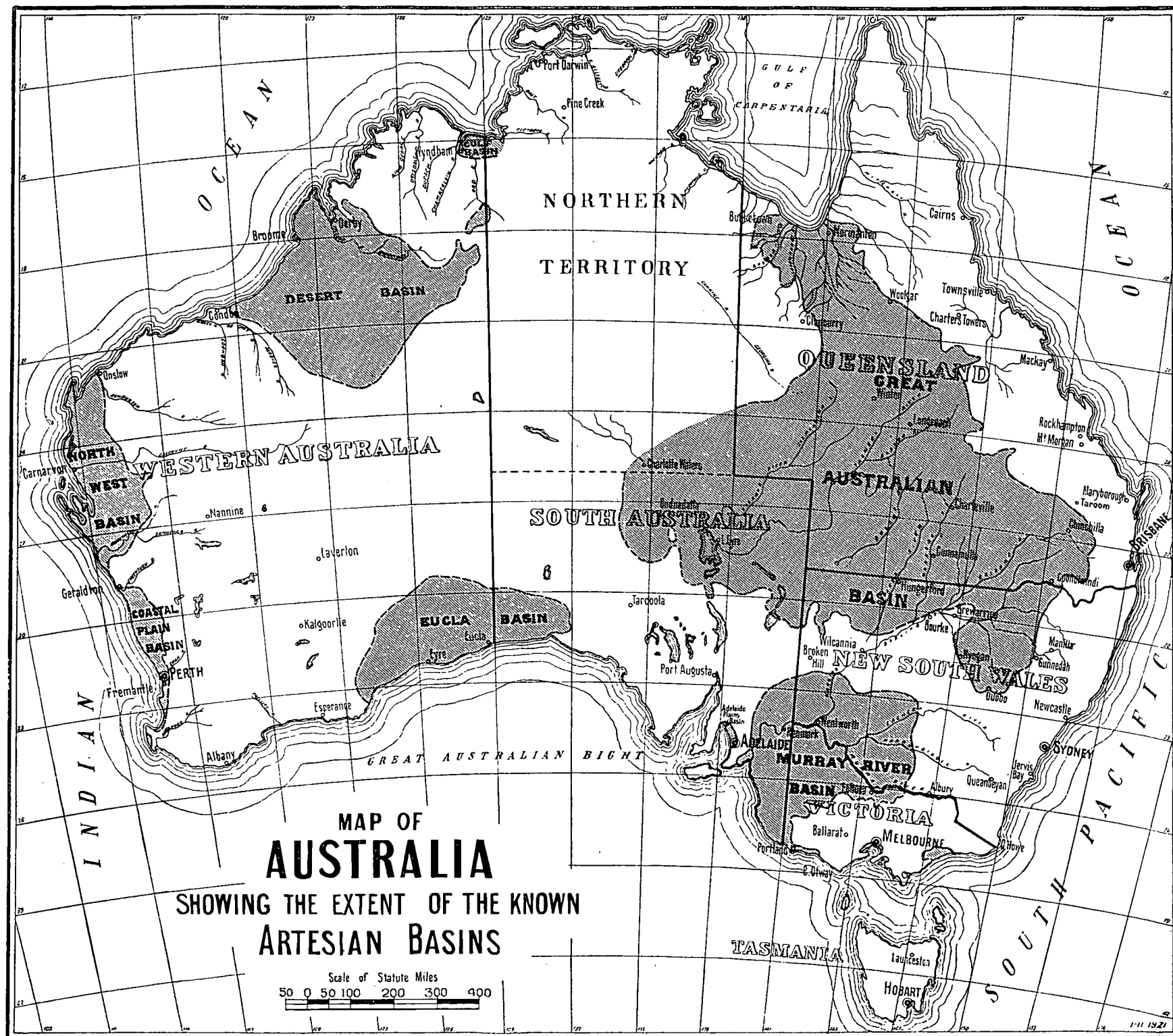
Hume Reservoir	..	..	..	180,000
Weir and Lock No. 11 (Mildura)	..	..	..	90,000
Completion of Torrumbarry Weir and Lock	..	..	..	1,000
Surveys, Investigations, and Supplies of Materials for other Weirs and Locks	..	..	..	29,000
				<hr/>
				300,000

South Australia—

Weir and Lock No. 2	..	..	..	50,000
Weir and Lock No. 3	..	..	..	30,000
Weir and Lock No. 5	..	..	..	100,000
Weir and Lock No. 9	..	..	..	80,000
Lake Victoria Works	..	..	..	35,000
				<hr/>
				295,000
				<hr/>
				£985,000

(v) *Gaugings.* The River Murray Agreement placed 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.



This map was included in the Report of the Third Interstate Conference on Artesian Water held in Adelaide during September, 1921. It contains the latest available information regarding the extent of the artesian basins. See also letterpress on page 867.

The gaugings made at the Renmark Gauging Station during the year 1922-23 indicated that the total flow of the river at that point was 4,400,417 acre-feet during the year. The flow at the same station during the preceding year was 14,180,792 acre-feet, the average for all years being about 8,500,000 acre-feet.

The approximate quantities of water diverted from the river by the three States by artificial or partly artificial means during the same period were as follow :—

			Acre-feet.
New South Wales	..	..	573,310
Victoria	..	..	912,260
South Australia	..	..	76,495
			<hr/> 1,562,065 <hr/>

(vi) *Proposal to utilize the Hume Reservoir for Hydro-electric Development.*—The question of the advisability of utilizing the Hume Reservoir works for the purpose of hydro-electric generation having been placed before the four Contracting Governments, a Conference representative of each of those Governments was convened to investigate the matter, and also to inquire into and report upon the question as to whether the reservoir could with advantage be enlarged.

The following estimates of cost of reservoirs of different capacities, including provision for special outlets for power, were furnished to the Conference :—

Capacity	Acre-feet.				Estimate of Cost.
1,100,000	£2,577,000
1,400,000	2,856,000
1,500,000	3,000,000
1,700,000	3,225,000
2,000,000	3,486,000

The cost of the additional work necessary to permit of the capacity of the reservoir being increased in the future to 1,500,000 acre-feet, assuming that the work is completed to the height required for a reservoir of 1,100,000 acre-feet, is estimated at about £250,000, while the estimated cost of such additional work to provide for increasing the capacity in the future to 2,000,000 acre-feet is set down at about £350,000.

The report of the Conference, in which are included the recommendations set out below, has been submitted to the four Contracting Governments, and now awaits consideration by a Conference of Ministers representing those Governments.—(1) That provision be made for outlet works at the Hume Reservoir suitable for the purpose of hydro-electric generation, in addition to the purposes set out in the River Murray Agreement, at an estimated additional cost of £40,000, and that the cost of such works be borne by the interested parties. (2) That the Hume Dam be carried to a height sufficient at present for a reservoir of a capacity of 1,100,000 acre-feet only, but that the work be constructed in such a manner as will permit of the dam being raised later to provide for a capacity of 2,000,000 acre-feet. (3) That the question of the benefits to be derived by each State from any increased storage provided, and the proportion of the additional cost to be borne by each party to the River Murray Agreement, be a matter for discussion and agreement by a Conference of responsible Ministers at an early date. (4) That the Governments concerned concur in the River Murray Commission at once approving of the expenditure during the next six months of a sum of approximately £20,000 in connexion with foundation work included in the estimate of cost of widening the base of the dam to permit of subsequently increasing the capacity of the reservoir; this matter to be treated as one of special urgency, as the work is being delayed pending decision as to width of the base of the dam.