

SECTION XIV.

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 the Commonwealth 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 section dealing with *Local Government*. In May, 1912, an Interstate Conference on artesian water was held in Sydney, at which it was agreed that combined Governmental action should be taken with reference to delimitation of the artesian basin, hydrographic survey, analyses and utilisation of artesian water, etc. (See map on page 439.)

(i) *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 (shewn approximately by the map on page 439) is said to be the largest yet discovered, and measures about 569,000 square miles, of which 376,000 square miles are in Queensland, 90,000 square miles in South Australia, 83,000 square miles in New South Wales, and 20,000 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).

(ii) *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 boring operations in these basins are referred to hereinafter (see page 441.)

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. But 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.

(iii) *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 several bores have been put down, and water has been struck at various levels.

(iv) *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 basin, together with the objections held thereto by a former Government Geologist of New South Wales.† (See Year Book No. 6, p. 570.)

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

COMMONWEALTH AND STATES.(a)—PARTICULARS OF ARTESIAN AND SUB-ARTESIAN BORES, 1920-21.

Particulars.	N.S.W.	Victoria. c	Q'land.	S. Aust.c	W. Aust.	N. Ter.	Total. c
Bores existing .. No.	504	314	3,874	146	173	159	5,170
Total depth bored .. feet	837,502	87,361	3,475,062	115,229	157,182	47,158	4,719,404
Daily flow .. ,000 gals.	85,210	b	318,300	b	52,452	b	b
Depth at which artesian water was struck—							
Maximum .. feet	4,207	700	6,000	4,850	c2,275	b	6,000
Minimum .. feet	70	150	10	55	c39	b	10
Temperature of flow—							
Maximum .. °Fahr.	140	b	210	208	c140	b	210
Minimum .. °Fahr.	76	b	81	82	c76	b	76

(a) There are no artesian bores in Tasmania. (b) Not available. (c) Government bores only.

2. *New South Wales.*—(i) *Artesian Water Supply.* The New South Wales portion of the great Australian basin, comprising approximately 70,000 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 which has been successfully effected by the Government and by private owners up to 30th June, 1921 :—

NEW SOUTH WALES ARTESIAN BORES, 1921.

Bores.	Flowing.	Pumping.	Total.	Total Depth.
For Public Watering-places, Artesian Wells, etc.	123	37	160	330,595
For Country Towns Water Supply	2	1	3	4,354
For Improvement Leases	34	3	37	58,412
Total Government Bores	159	41	200	393,361
Private Bores	222	82	304	444,141

The average depth is 1,967 feet in the case of Government bores, and of private bores 1,461 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 924,990 gallons; and at Dolgely, in the Parish of Carenga, in County

* 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.

Stapylton, with a depth of 4,086 feet, and a present discharge of 534,406 gallons per day. The largest flow at the present time is that at the Wirrah bore, in the County of Benarba, which yields 1,079,776 gallons a day, and has a depth of 3,578 feet.

Of the 552 bores which have been sunk, 381 are flowing, and give an aggregate discharge of 85,209,550 gallons per day; 123 bores give a pumping supply, the balance of 48 being failures; the total depth bored represents 898,444 feet.

The flow from 78 bores is utilised 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 34,543,740 gallons per day, watering an area of 4,556,024 acres by means of 2,820 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 utilised 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.

(ii) *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 28 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 726 bores put in hand up to 30th June, 1921, 132 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) *Private Artesian Bores.* Much has been done in the way of artesian boring by private enterprise. As far as can be ascertained, 323 private bores have been undertaken in New South Wales, of which 24 were failures. The yield of the flowing bores is estimated at 37.8 million gallons per day. No data are available regarding the pumping bores.

3. *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. But as the water was 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, 92 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 30th June, 1921, the number of existing bores in use in the north-western portion of Victoria was 314, from which supplies are obtained by pumping. The total depth bored amounted to 87,361 feet, while the maximum and minimum depths at which water was struck were 700 and 150 feet respectively. The figures include also about 206 existing private bores, with a total depth of about 41,800 feet.

4. Queensland.—A return relating to the 30th June, 1921, classifies the Queensland artesian bores under the following headings :—

QUEENSLAND ARTESIAN BORES, 30th JUNE, 1921.

Sunk by—	Artesian Flows.	Sub- Artesian or Pumped Supplies.	In Progress, Abandoned, or Uncertain.	Total.
Government	66	89	143	298
Local governing authorities	16	22	22	60
Private owners	1,172	1,417	927	3,516
Total	1,254	1,528	1,092	3,874

The estimated yield of water from 1,254 flowing bores on 30th June, 1921, was 300,140,000 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 analysed, 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.

The following table shews particulars as to Queensland bores at the end of June, 1921 :—

QUEENSLAND ARTESIAN AND SUB-ARTESIAN BORES, 30th JUNE, 1921.

Particulars.	State and Local Authorities.	Private.	Total.
Bores existing No.	358	3,516	3,874
Total depth bored feet	285,968	3,189,094	3,475,062
Daily flow gallons	36,500,000	281,800,000	318,300,000
Depth at which artesian water was struck—			
Maximum feet	4,256	6,000	..
Minimum "	354	10	..
Temperature of flow—			
Maximum °Fahr.	198	210	..
Minimum °Fahr.	85	81	..

5. *South Australia.*—There were in South Australia 146 Government bores existing at 30th June, 1921, of which 36 were artesian and 110 sub-artesian. Of these, 108 were under 1,000 feet in depth; 24 from 1,000 to 2,000 feet; 6 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 shews particulars as to South Australian bores at 30th June, 1921 :—

SOUTH AUSTRALIAN BORES, 1921.

Particulars.	Artesian and Sub-artesian.
Bores existing	146
Total depth bored feet	115,229
Daily flow gallons	(a)
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, 1921	£329,339
Expenditure during year on boring operations	£8,704

(a) Not available.

(i) *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 Kumara in the Hundred of Kingsford, and Perponda in the Hundred of Vincent. The former has a depth of 240 feet, and the water, which is in large supply, rises to within about 96 feet of the surface. The latter is 300 feet in depth, and the water rises to within 56 feet of the surface. The water is fresh, containing about $\frac{3}{4}$ oz. salts and other solid matter per gallon.

(ii) *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, Appreitinna, 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.

(iii) *Other New Bores.* The Moutecollina Bore, on the Innamincka Track, has been completed, being sunk to a depth of 2,550 feet, and a splendid supply of good artesian water was struck at 2,450 feet. No. 2 bore, in the Stuart's Range Opal Fields, was sunk to a depth of 1,000 feet, and a useful supply of sub-artesian water obtained. Good water has also been struck in a new bore known as Glenmanyie, which is being put down on Pastoral Lease 1286.

(iv) *Eyre Peninsula.* From time to time bores have been sunk on Eyre Peninsula but with little success. In some instances, stock water ($1\frac{1}{2}$ ozs. salts to the gallon) was obtained, but this only occurred on the Nullarbor plains. In all other cases the water struck was far too salt to be used. Consequently the supply of water is now principally from catchments. A number of reservoirs have been constructed to hold from 1,000,000 to 9,000,000 gallons each. Many underground tanks have been built to contain from 40,000 up to 500,000 gallons each.

6. *Western Australia.*—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.)

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

The following table shews particulars as to Western Australian artesian bores at 30th June, 1921 :—

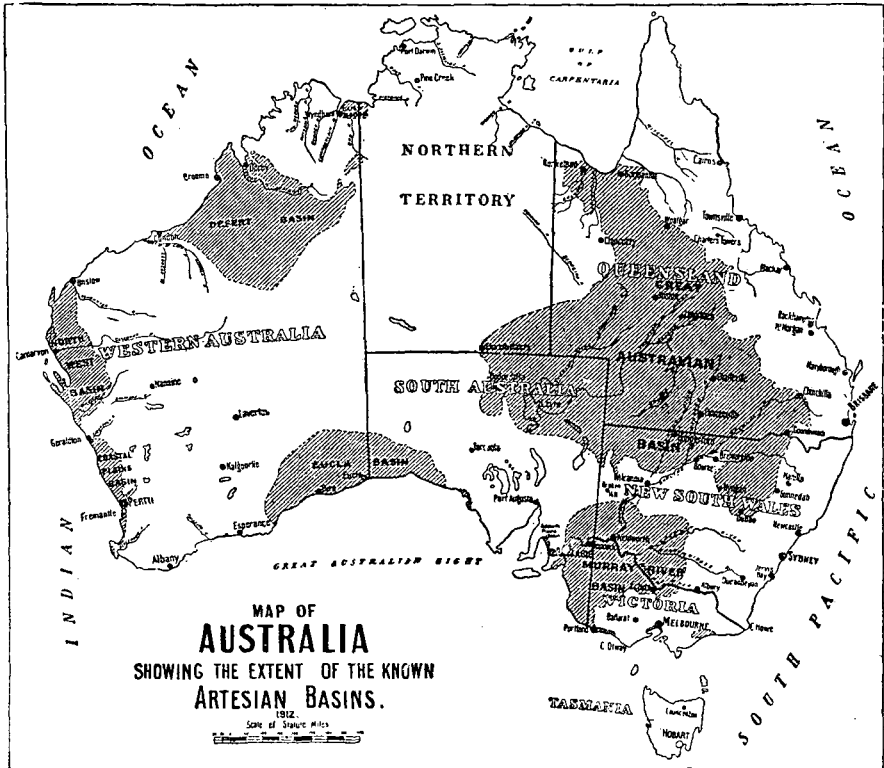
WESTERN AUSTRALIAN ARTESIAN BORES, 30th JUNE, 1921.

Particulars.				State.	Private.	Total.
Bores existing	..	..	..	94	79	173
Total depth	..	..	feet	91,570	65,612	157,182
Daily flow..	..	..	gallons	23,700,300	28,751,500	52,451,800
Depth at which artesian water was struck—						
Maximum	..	..	feet	2,275	(a)	..
Minimum	..	..	feet	39	(a)	..
Temperature of flow—						
Maximum	..	..	°Fahr.	140	(a)	..
Minimum	..	..	°Fahr.	76	(a)	..

(a) Not available.

To 30th June, 1921, the total number of Government bores was 94, and there were approximately 79 private bores recorded in addition.

MAP SHEWING THE POSITION AND EXTENT OF THE "AUSTRALIAN ARTESIAN BASINS."



This map was prepared by the Interstate Conference on Artesian Water, held in Sydney during May 1912. It contains the latest facts relative to the various artesian basins of the Australian continent. Of these basins the most important is the Great Australian Basin, which is about 569,000 square miles in extent, viz.:—About 376,000 square miles in Queensland, 90,000 square miles in South Australia, 83,000 square miles in New South Wales, and 20,000 square miles in the Northern Territory. The Murray River Basin extends over South-Western New South Wales, North-Western Victoria, and South-Eastern South Australia. The Western Australian Basins fall naturally within five groups, viz.:—The Eucla Basin, the Coastal Plains Basin, the North-West Basin, the Desert Basin, and the Gulf Basin. (See also pages 433 to 441.)

The boring operations which have been carried out in the artesian basins along the West Australian Coast are as follows :—

(i) *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 40 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.

(ii) *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 put under stock. Some remarkable flows have been obtained and, in one case, at a depth of 300 feet a flow reputed to be 3,000,000 gallons per day was struck, the water being suitable for stock. In all, about 61 bores have been put down.

(iii) *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 7 bores have been sunk, 3 being at Broome, 2 at Derby, and 2 on the telegraph line on the road between Derby and Hall's Creek, about 67 and 80 miles inland.

(iv) *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 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. This was followed later with about 20 bores 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 estimated supply was about 10,000 gallons per day.

7. Northern Territory.—In the Northern Territory, bores to the number of 159 were put down up to 30th June, 1921, 51 belonging to the Commonwealth Government. This number does not include bores put down by hand-boring plants for test purposes. One bore is artesian, and 158 give a pumping supply. The cost of construction and equipment of the Government bores exceeded £20,000. The total depth bored in State and private bores was 47,158 feet. Maximum depths were 1,474 feet in State, and 1,760 feet in private bores, and minimum depths were 110 feet and 60 feet respectively.

§ 2. Irrigation Schemes.

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 for the most part 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 big estates and large farms, 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 recognised.

2. *New South Wales.*—(i) *Water Conservation and Irrigation Works.* The provision of an adequate water supply for other than domestic purposes is essential to the well-being of all primary industries, and particularly in a country liable to dry seasons which affect extensive areas. A large portion of the State receives an adequate and regular rainfall, but there is a considerable extent of country where all the factors exist which are requisite for success in agricultural pursuits excepting only a constant water supply. The recognition of the fact that the area suitable for cultivation might be extended largely by a comprehensive system of water conservation and irrigation has induced the Government to undertake various detached works and schemes, which will constitute portion of the ultimate irrigation 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, natural 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 to retain the floodwaters, which will be released for use lower down the river during the dry summer months; a movable diversion weir, 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, also roadways to serve each farm, and a general surface drainage system, are also included in this scheme.

The site of the storage dam is at Burrinjuck, three miles below the confluence of the Murrumbidgee and Goodradigbee Rivers. The dam wall is being constructed of cyclopean masonry and concrete, and when completed will have a maximum height of 240 feet, and will impound the waters in a lake covering 12,740 acres. Ample water is being stored to meet the requirements of the farms already occupied, and to allow of water being drawn off during the summer months to augment the natural flow of the river for the benefit of riparian holders down stream. The reservoir will have a capacity of 33,612 million cubic feet, or 771,641 acre feet, the catchment area being about 5,000 square miles, drained by three principal streams—the Murrumbidgee, Goodradigbee, and Yass Rivers—up which the water will be backed, when the dam is full, to distances of 41 miles, 15 miles, and 22 miles respectively. Direct communication between Burrinjuck and the Main Southern railway has been provided by the construction of a 2-ft. gauge line from Goondah, a distance of 26 miles.

The diversion weir is situated at Berembed, about 40 miles by river and 19 miles in a direct line above the town of Narrandera. It is founded on a solid granite bar extending across the river, and has a length over all of 270 feet between abutments, divided into a sluiceway 40 feet wide in the clear; a lock chamber, 40 feet wide, capable of taking barges up to 100 feet in length; and 55 channoiné wickets, manipulated from a punt moored up-stream. During the winter freshets the wickets are lowered, thus affording a clear water-way in the river channel.

The main canal branches from the river just above the weir, and, after passing through Narrandera, continues in a north-westerly direction, skirting the hills abutting on the plains. A scheme for enlarging the main canal to double its present capacity (1,000 cubic feet per second) has been approved by Parliament and the work is now in progress. The principal canals are the Gogeldrie canal, which off-takes at 47 miles from Berembed, and runs approximately parallel to the Narrandera-Hay railway through the Yanco area; the Mirrool branch canal, which off-takes at 78 miles from Berembed and supplies portion of the Mirrool area; the Northern branch canal, which off-takes at 76 miles from Berembed; and the Lake View branch canal, which off-takes at 93 miles from Berembed.

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, cantaloups, 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 already being successfully undertaken by settlers in the areas, and the canning and drying of fruit is becoming an industry of large dimensions.

The first area made available for settlement was in the vicinity of Yanco siding on the Hay railway line. The second, which is situated on the northern side of the Mirrool Creek, is served by the branch railway from Cootamundra, which now terminates at Griffith, but which it is proposed to extend to Hillston. A railway connecting these two lines and running from Yanco to Griffith railway stations, right through the irrigation areas, has recently been completed and opened for traffic.

Further areas are being thrown open for settlement as the construction works are completed. Farms varying in size from 2 acres to over 200 acres have been made available. The "water right" or number of "acre feet" of water allotted to each holding is specified when the holding is notified as available for application. An "acre foot" of water means such a quantity, 12 inches deep, as would cover an area of one acre. The cost of water supplied by gravitation ranges from five shillings to ten shillings per acre foot. The average horticultural farm is from 15 to 25 acres, but to suit the requirements of dairymen and other stock farmers, blocks of larger areas have been made available. These comprise non-irrigable or "dry" areas, in addition to the irrigable portion. Some of these larger farms are 200 acres or upwards in extent, but the maximum water right allowed in respect of these larger farms is generally 80 acre feet. Additional water may be obtained, if available, by arrangement.

The conditions for the disposal of irrigation blocks are contained in the Crown Lands Consolidation Act of 1913, and Amending Acts. Any person of or over the age of sixteen years, if a male, or eighteen years if a female (other than a married woman not living apart from her husband under decree of judicial separation), or two or more such persons jointly, may apply for a farm or block. A married woman, not judicially separated from her husband, may, however, if she be not subject to any other statutory disqualification, (a) acquire by way of transfer, with the consent of the Minister, out of her own moneys, a lease within an irrigation area; (b) continue to hold a lease which she held before her marriage; (c) hold a lease which may devolve on her by will or intestacy of a deceased person. The tenure is perpetual leasehold.

The improvement conditions attached to the farm holdings include fencing, planting trees for windbreaks, construction of dwellings, and destruction of noxious plants.

Subject to such conditions as to security and terms of repayment as the Commission may think fit to impose, settlers may obtain an advance, or have payment of amounts owing suspended. Such advances are limited to the total amount of funds made available by Parliament for this purpose. The amount of assistance now being granted to settlers, by the Commission, is not as great as formerly, since the Government Savings Bank Commissioners now have statutory power to make loans upon mortgage of irrigation farm leases, and many settlers have already obtained help from the Bank. The Commission has financially assisted the co-operative organisations formed by settlers in connection with the handling and marketing of their produce, reference to which is made later. Concessions in railway fares and freights are made on New South Wales railways to bona fide applicants for land.

A large area of land on both the Yanco and Mirrool sections of the areas has been specially reserved for discharged soldiers. Upon taking up residence on their farms these settlers will, subject to their intelligent and energetic use of the advances made, as well as their own labour, in the improvement of their farms, be provided with funds up to £625 to enable them to develop their holdings, and in addition thereto such further

advances up to certain definite limits fixed by the Commission may be made from time to time as found necessary to bring the farms to a proper stage of productiveness. All payments for rent, etc., and repayments of advances will be suspended in the case of fruit farms for five years and in the case of dairy farms for two years from the date of granting of the farm. The total indebtedness including interest will then become payable by instalments extending over a period of twenty years.

Towns and villages have been established at centres of the Yanco and Mirrool Irrigation Areas. The Commission is empowered to construct streets, and to provide water supply, sanitary, and other services.

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 285 tons, from between 160 and 170 suppliers. The factory also 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 also been successfully floated for the handling of fruit not suitable for canning. Extensive dehydration works have been established and successful pooling schemes 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.

One of the most important departmental undertakings on the irrigation areas is undoubtedly the State Nursery. For some years past the Leeton Nursery has been supplying trees to settlers, and in 1916 a second nursery was established at Griffith. Every effort is made to supply only the very best trees, free from disease, and to ensure this, as much use as possible is being made of budding wood from proven trees in the Leeton Nursery, and at the Yanco Experiment Farm.

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 and Yanco, and the supply is also available for settlers when the number of applicants in any centre warrants the connections being made. Griffith also has this convenience to a limited extent so far as lighting is concerned.

On the 30th June, 1921, 1,361 farms were held, representing a total area of 75,974 acres, and the number of town blocks held was 543.

In the matter of cultivation, the following particulars indicate the extent of the work performed by the settlers:—There are approximately 5,548 acres under deciduous fruit, 2,485 under citrus fruits, and 2,443 under vines. The estimated population of the areas is about 8,700.

(iii) *Other Irrigation Settlements.* Irrigation settlements have been established at Curlwaa near Wentworth, and at Hay. These were placed in 1913 under the control of the Water Conservation and Irrigation Commission.

(a) *Curlwaa Irrigation Area.* The Curlwaa Irrigation area embraces 10,600 acres, of which on 30th June, 1921, irrigable holdings, comprising 1,426 acres, had been taken up, in areas of $1\frac{1}{2}$ to 40 acres. 98 non-irrigable holdings of from $\frac{1}{4}$ to 336 acres, representing an area of 6,967 acres, were in occupation on the above date. The balance of the area is made up of roads, common, channel and other reserves. Of the irrigable area 871 $\frac{3}{4}$ acres are planted as orchards and vineyards, of which 665 $\frac{1}{2}$ acres are in full bearing. There is also a small area under lucerne. It has been proved beyond doubt that the Curlwaa soil is eminently suited to the growth of citrus and other kinds of fruit. 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 1920–21 was 7,032 cwt., the principal yields being sultanas, 2,099 cwt.; peaches,

1,577 cwt. ; and currants, 1,537 cwt. In the previous year the product was 8,038 cwt. ; in 1918-19, 7,992 cwt. ; in 1917-18, 6,580 cwt. ; in 1916-17, 4,865 cwt. ; in 1915-16 it was 5,955 cwt. ; in 1914-15 it was 3,178 cwt. ; in 1913-14, 5,118 cwt. ; and in 1912-13, 4,247 cwt. The heaviest crops were sultanas and currants. The value of the dried fruit production for the twelve months ending 30th June, 1921, is estimated at £40,471 ; in addition to which the area produced fresh fruit, crops, and other produce of the value of £14,370.

The pumping machinery consists of a suction-gas plant, one engine of 128 brake horse power driving one eighteen inch centrifugal pump and two engines each of 55 brake horse power driving a ten inch centrifugal pump. The average combined capacity of the pumps is 10,600 gallons per minute. With five pumpings during the 1920-21 season, 147,898,000 cubic feet of water were supplied. The length of the main channels is about 9 miles 10 chains. The land may be leased for periods not exceeding 30 years, the annual rent at present varying from 1s. to 24s. per acre. The rate for water is fixed from time to time by the Commission, and is at present, except in a few special cases, 20s. per acre per annum. Each lessee is entitled to receive a quantity of water equivalent to a depth of 30 inches per annum, limited to 4 inches in any one month.

There has been a keen demand for land, and values have generally increased. Surveys of extensions to the area comprising 966 acres have been completed, and it is intended to throw open 450 acres for application at an early date. A number of new dwellings have been erected, and others are in progress and projected.

Satisfactory progress has been made in the development of an area set apart two years ago for settlement by returned soldiers.

(b) *Hay Irrigation Area.* The Hay irrigation area consists of about 4,500 acres, and previous to 1913 was controlled by a Trust appointed in 1897. On 30th June, 1921, the area held and used for irrigation purposes was 1,039 acres, in 109 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. The water rate is fixed from time to time, and during 1920-21 was £1 10s. per acre per annum. The pumping machinery is of similar type to that at Curlwaa, the capacity of the pumps being 4,000 gallons per minute. During the 1920-1921 season 109,889,200 cubic feet of water were pumped with seven pumpings. Dairying is the principal industry ; the cultivation of fruit is very limited.

(iv) *Projected Irrigation Schemes.* The Water Conservation and Irrigation Commission are investigating schemes for utilising 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, Peel, and Warragamba Rivers.

(a) *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.

(b) *Lachlan River.* The construction of a storage reservoir at Wyangala, below the confluence of the Abercrombie River, is being investigated with the intention of affording 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, and for the pumping thence of the water for the irrigation of an area of about 5,000 acres adjacent

to the lake. The possibility of regulating the amount of water diverted into numerous effluent creeks is being considered, so that the best use may be made of the Lachlan River water.

(c) *Macquarie River.* The construction of a storage reservoir on the river at Burrendong, 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.

(d) *Hunter, Namoi, and Peel Rivers.* Pumping by private irrigators under license 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. Surveys have been completed for storage dams on the Hunter and Peel Rivers and for a dam on the Namoi River above Manilla.

(e) *Warragamba River.* The Warragamba project will serve the dual purpose of augmenting the Sydney Water Supply and irrigating the best lands in the Nepean Valley. The rate of increase in the population of the metropolitan area during recent years, if maintained, will in a short space of time cause the consumption of water to overtake the capacity of the present catchment area of the Sydney water supply, and the next available source of supply will then be the Warragamba River, where a scheme for the storage of water has been investigated. It is proposed to construct a large storage dam capable of supplying about 200,000,000 gallons daily for water supply, irrigation and trade purposes, and for compensation water. Surveys have been made and details are being prepared of this scheme.

(v) *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 arise within the land of two or more occupiers is vested in the Crown. Private rights are abolished, riparian law is simplified, and a system of licenses 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, and it also enables such owners to obtain licenses to supply water to other occupiers of land not adjoining a river or lake.

During the year ending 30th June, 1921, 198 applications were received for fresh licenses, comprising 147 in respect of pumps, or pumps in conjunction with dams or other works, 39 in regard to dams, and 12 other works. The number of applications received for the renewal of existing licenses was 229; 160 of the applications were in respect of pumps, in some cases used in conjunction with dams or other works, 60 respecting dams, and 9 race and other works. Approximately, 1,343 licenses were in force on the 30th June, 1920, and in the succeeding twelve months 217 new licenses were issued and 79 were allowed to lapse, so that there were about 1,481 licenses current on the 30th June, 1921.

(vi) *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, and for drainage, the liabilities on which are repaid to the Crown, with interest spread over a period of 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-eight 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 three instances for the construction of weirs across stream channels; and (d) two pumping schemes, one from natural watercourses, and one from a well. The total area included within these trusts amounts to 7,642,171 acres.

3. *Victoria.*—(i) *Classification of Works.* The Water Conservation Works in Victoria divide themselves into 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. With the exception of the works administered by the Commission, particulars as to these works will be found on the section on *Local Government* in this volume.

(ii) *Works Controlled by the Commission.* 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.

(A) IRRIGATION SCHEMES. This division comprises the schemes constructed and under construction for the supply of water to some twenty 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, 1921, on water supply in the irrigation and water supply districts under the control of the Commission and at Mildura, exclusive of the amount (£278,000) expended by it on River Murray Agreement Works, was £5,091,000. The irrigation works draw their supplies mainly from headworks constructed on the Murray, Goulburn, and Loddon Rivers. The cost of these headworks which now stands at £1,124,000 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 283,000 acres. Although this is 88,714 acres less than the record area irrigated in the year 1919-20, it is nearly 32,000 acres above the average of the previous four years.

The following particulars of the principal schemes will be of interest, and will convey some idea of the extent to which the one-time arid northern portion of this State is now insured against droughts like that of 1902, when the combined capacities of its storages for irrigation by gravitation were only 75,000 acre feet, and of its pumping plants, 400 acre feet per day.

(a) *Goulburn Scheme.* The Goulburn River Gravitation Scheme (see Official Year Book No. 13, map on page 561) is the largest of Victoria's irrigation enterprises. It serves, either for irrigation or domestic and stock purposes, 868,000 acres of land in the valleys of the Goulburn, Campaspe and Loddon Rivers. The present headwork of the system is a diversion weir on the Goulburn River, near Nagambie. It is constructed of concrete masonry, with 21 flood gates, which raise the up-stream water level 10 feet above the concrete crest. These gates are lowered, during high stages of river flow, to provide a clear waterway for the discharge of floods. The weir has a total length, including channel regulators, of 925 feet, and a height of 50 feet. The water is diverted by two main channels, the eastern carrying 330 cubic feet per second (660 acre feet per day) a distance of 33 miles to the country north of the Broken River, while the western, which has a capacity of 1,700 cusecs,* and a length of 23 miles, is used to feed distributaries of the Rodney District and to fill Waranga Reservoir, the present principal storage basin of the scheme. This reservoir, formed by an earthen embankment $4\frac{1}{2}$ miles long across a natural depression, covers an area of $22\frac{1}{2}$ square miles to an average depth of 23 feet, and stores 333,400 acre feet. Two main channels issue from this reservoir, the Waranga-Rodney, of 250 cusecs* capacity, which feeds Rodney distributary channels, and the Waranga-Campaspe-Serpentine, which leaves the reservoir with a capacity of 1,000 cusecs, and ends at the Serpentine Creek, 92 miles westward, with a capacity of 200 cusecs. The total length of distributary channels is 1,650 miles.

With a view of meeting the increasing demand for water in dry seasons, and providing an irrigation supply for other suitable lands, the Commission is constructing a storage

* Cusecs = Cubic feet per second.

reservoir on the Upper Goulburn, just below its junction with the Delatite River, at what is known as the Sugarloaf site. The dam, which is 2,550 feet in length, consists of a diaphragm wall of reinforced concrete, built from bed rock (in some places 75-feet below natural surface) to crest level 135 feet above the river bed; a wall of clayey material on the upstream side of the diaphragm; and supporting masses of rock. This reservoir will submerge an area of 7,600 acres, and store about 300,000 acre feet of water, bringing the total capacity of the Goulburn storages to 654,000 acre feet. The foundations of the Sugarloaf structure will permit of the dam being raised, if necessary to a height of 190 feet above the river bed. This would add 8,600 acres to the area submerged, and would increase the storage capacity from 300,000 to 900,000 acre feet. The construction of the first stage of this reservoir is nearing completion, and the storing of water will be commenced in 1922.

The portion of the State served by this system comprises 19,000 acres east of the Goulburn, 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, and Dingee (see "Closer Settlement in Irrigation Districts," page 177), in which annual water rights are allotted of not less than one acre foot of water to each acre of irrigable land. They include also the districts formerly controlled by the Rodney and Tragowel Plains Irrigation Trusts, in which districts, generally, the holdings are larger than in Closer Settlement areas. The water rights in these districts are, for lands under intense culture, one acre foot of water to each irrigable acre, and for other irrigable lands, one acre foot to four irrigable acres in the former district, and one to five in the latter. The balance of the area, including Deakin district, while not subject to a compulsory irrigation charge, 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 6s. per acre foot in the two districts—Tragowel Plains and Dingee—farthest removed from the sources of supply, and 5s. per acre foot elsewhere.

(b) *Loddon River Scheme.* This also is wholly a gravitation system. The headwork is a regulating weir on the Loddon at Laanecoorie, about 22 miles westerly from Bendigo. This weir is constructed of concrete masonry with "Chaubart" automatic floodgates five feet high for a length of 320 feet, combined with an earthen embankment, the length over all being 940 feet. Its storage capacity is 14,000 acre feet. Other works of the scheme are timber diversion weirs at Serpentine and Kinypanial, 80 and 120 miles downstream respectively, also 160 miles of channels (taken over from several irrigation Trusts in the Boort district) which supply an area of 74,000 acres for domestic and stock purposes and partial irrigation.

(c) *Murray River Schemes.* These comprise both gravitation and pumping schemes. The only wholly gravitation system is that known as the Kow Swamp scheme, which supplies the Kerang irrigation district of some 85,000 acres. The off-take is at Torrumbarry headworks, from which the Gunbower channel diverts water, when the Murray River is five feet above summer level, to the Kow Swamp storage, a natural depression improved so as to hold a volume of 41,000 acre feet. From this reservoir the water is distributed by the Macorna channel (40 miles in length) and about 200 miles of distributaries.

The Cohuna, Gannawarra, Koondrook and Swan Hill Schemes are combined gravitation and pumping schemes. The Cohuna-Gannawarra plant consists of two 36 inch and four 39 inch centrifugal pumps—total capacity 280 cusecs*; those at Koondrook and Swan Hill, each of 100 cusecs capacity, consist each of two 39 inch centrifugal pumps. The pumped supplies are supplemented at varying stages of river level by the gravitation water. When the Torrumbarry dock weir, now being constructed under the River Murray Agreement is in operation, these pumping plants will not be required, as the raising of the water level in the River Murray, by this work, will enable irrigation supplies to be taken by gravitation throughout the irrigation season.

The Cohuna, Koondrook and Swan Hill Districts, comprising 107,000 acres, embrace the irrigated Closer Settlements of the same names. In these districts and that of Gannawarra (comprising 44,000 acres) the quantity of water allotted as a "right" is one

* Cusecs = Cubic feet per second.

acre foot per irrigable acre. The compulsory charge is at present 5s. per acre foot of such water right. In Kerang district—not 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 2,600 acres of irrigable land have been purchased for soldier settlement, and subdivided into 83 holdings. The channel system has been correspondingly extended.

The Nyah Irrigation Area was occupied in 1894 under village settlement conditions, settlers being allowed up to 50 acres each. Individual attempts at irrigation having proved unsuccessful, a Government scheme was prepared for the whole settlement. A number of settlers surrendered portions of their holdings, which were too large for effective working, and these portions, with adjacent Crown lands, were re-subdivided and made available, under the Murray Settlements Act 1907, on easy terms. Water is diverted from the Murray by a high lift pumping plant—capacity 45 cusecs*—consisting of four coupled 24 inch centrifugal pumps. The settlement now contains 3,800 acres, subdivided into 208 holdings, of an average area of 17 acres, of which 200 are settled. The settlers include 57 discharged soldiers. The channels have been extended to the soldiers' holdings and an additional pumping plant erected to meet the increased demand for water. Water rights are apportioned to these holdings on the basis of 2½ acre feet of water for each irrigable acre, and the compulsory charge is at present 16s. 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 of what, twelve years ago, were Crown lands. This settlement now contains 384 holdings, averaging 21 acres each. These holdings also, when fully improved, sell at very high prices. The water is pumped from the Murray by two 36 inch high lift centrifugal pumps, capacity 50 cusecs* each, and one 24 inch turbine centrifugal pump, capacity 20 cusecs. The land settlement conditions and water rights apportioned are the same as at Nyah, but the compulsory charge is at present 20s. per acre foot. The Crown lands added to this district for soldier settlement furnished 160 holdings. All are now connected with the channel system, and the pumping plant has been enlarged to ensure an efficient supply of water.

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 (see page 179). The scheme of works for this district includes a pumping plant which will have a capacity of 250 cusecs, or 500 acre feet per day—lifted 105 feet. One unit, a 36 inch high lift centrifugal pump (capacity 50 cusecs) has been installed, and the remainder of the plant—two 48 inch turbine pumps (capacity 100 cusecs each)—are under construction. Each pump will be driven by a 1,600 b.h.p. steam turbine. The rising main is of reinforced concrete, 6 feet 6 inches diameter, length 34 chains. An electric generator, of about 350 k.w. capacity, will be installed to provide for relifts, to water those parts of the area above the general level.

(d) *Werribee River Schemes.—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 dam, 1,000 feet in length and 100 feet in height, is built of earth, with dwarf concrete core. The area of the district is 6,600 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 £1 per acre foot of such right. The higher portion of the district receives a supply for domestic and stock purposes.

Werribee. This is another gravitation scheme on the same river. The headwork is a reservoir at Melton, immediately below the Bacchus Marsh district. The dam is of earth, with dwarf concrete core. Its length is 600 feet, height 100 feet, and the storage capacity of the reservoir 17,000 acre feet. A diversion weir

*Cusecs = Cubic feet per second.

at Werribee, 17 miles downstream from the reservoir, a main channel therefrom, and the usual distributaries and appurtenant works, complete the scheme. The irrigation district comprises 8,100 acres of first-class land, being the irrigable portion of the Werribee Closer Settlement Estate, which is within 20 miles southwesterly of Melbourne. The water right allotment is one acre foot per irrigable acre, and the charge at present is 10s. per acre foot. The non-irrigable portion of the estate, containing about 13,000 acres, is supplied with water for domestic and stock purposes.

(B) 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, 1921, was £5,546,000. The area of country lands artificially supplied with water for these purposes is nearly 21,000 square miles. The number of towns supplied, exclusive of the City of Melbourne and its suburbs, is 167, serving an estimated population of 328,700. In addition to the Commission's districts, some large areas are still administered by local authorities.

(b) *Wimmera-Mallee System.* The principal scheme in this division is that known as the *Wimmera-Mallee Gravitation Channel System*. This comprehensive scheme of works will compare favourably, it is believed, with any similar individual scheme for domestic and stock service, in any part of the world. The main supply is drawn from three reservoirs in the catchment area of the Wimmera River, at the foot of the Grampians Ranges, viz.:—Lake Lonsdale, Wartook, and Fyars Lake. A fourth—Taylor's Lake—now under construction, is nearing completion. The reservoirs in use, including some minor works, have a combined storage capacity of 118,000 acre feet. The completion of the works in progress will bring this total to 200,000 acre feet. The water is conveyed, partly by natural water-courses, but chiefly by artificial channels, aggregating over 4,000 miles in length, over farming districts comprising about 9,000 square miles, approximately one-tenth 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 92, their average depth being 420 feet. There are also 161 tanks, having a total capacity of 900,000 cubic yards, or 152 million gallons.

(d) *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 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, Aspendale, and the intervening bayside towns.

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.

(e) *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. Under these provisions 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.

(iii) *Mildura.* The creation of an irrigation colony at Mildura was the outcome of a visit by Mr. Deakin to California in 1885, when Messrs. Chaffey Bros. were invited to visit Victoria, with the object of founding a similar settlement to those which they had been largely instrumental in establishing in California.

Active operations were commenced in 1887, since which date marvellous progress has been made, instanced in the fact that, originally used as a sheep run and carrying one sheep to every thirty acres, the dried fruit harvested from 13,000 acres in 1920 was valued at £1,238,373 gross.

Water is pumped and supplied under Act of Parliament by the First Mildura Irrigation Trust from the river Murray from two pumping stations:—(1) into a billabong, and thence to pumps lifting to various levels, and (2) to a comparatively small area adjacent to the town.

The length of the Trust's main and subsidiary channels is 280 miles. For the year ending 30th June, 1921, the Trust's receipts aggregated £38,292, and its expenditure £45,830. For the same period the number of water acres supplied was 35,632.

Loans (balance) advanced to the Trust by the Government for the purpose of improving the plants and channels, etc., amounted at 30th June, 1921, to £94,900. exclusive of the sum of £8,548 (balance) arrears of interest.

The area of the settlement is 45,000 acres, of which 13,000 acres are under intense culture, vines predominating.

4. **Queensland.**—The main irrigation works in Queensland are as follows:—(a) those at Ayr, which utilise the waters of the Burdekin River, and shallow wells on its banks; (b) Townsville (wells, creek, and river); (c) Rockhampton (wells, river, creek, etc.); (d) those at Bingera, near Bundaberg, which utilise water pumped from the Burnett River just above the point of meeting of the salt and fresh waters, and (e) those at Fairy-mead, which utilise water pumped from a number of shallow spear wells sunk on the alluvial flats on the north side of the Burnett River and about six miles from Bundaberg. There were 704 irrigators in the State in 1920, chiefly farmers and graziers, and the area irrigated was 9,803 acres.

5. **South Australia.**—(i) *The Renmark Irrigation Trust.* The Renmark Irrigation Trust was established in 1893 on similar lines to Mildura, but on a smaller scale. The area of settlement is 21,000 acres, the area under irrigation being 7,360 acres. There are also 1,000 acres under crop for hay. The dried fruit pack for 1921 was 1,450 tons, green fruit 5,000 tons, and the gross value of the production for the year exceeded £235,000. The population of the town and settlement is 4,000. The chief products are sultanas, currants, raisins, oranges, apricots, peaches, pears, prunes, olive oil, and grape spirit. There are two distilleries for the manufacture of grape spirit, and several packing sheds for dried fruits.

(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 Section xxvi., *Local Government.*)

(iii) *Area under Irrigation.* The Irrigation Areas on the River Murray above Morgan under Government control, up to the end of February, 1922, contained 15,039 acres of irrigable land, allotted to 874 settlers, about 1,300 acres reserved by the Department for fodder cultivation, etc., 1,600 acres ready for allotment, and about 23,000 acres in course of preparation. The pumping plants at present installed on these areas aggregate 5,698 horse power, with a pumping capacity of 6 million gallons per hour.

The *Cadell Irrigation Area* is 7 miles by river above Morgan. Total area of settlement, 2,726 acres, of which 1,183 are irrigable. Blocks have been allotted to 77 soldier settlers, and the balance is ready for allotment in 10 blocks. The area is suitable for fruit growing. First allotment 30th September, 1919. The pumping plant is a 190 b.h.p. steam plant with centrifugal pump, capacity 4,200 gallons per minute against a head of 90 feet.

The *Waikerie Irrigation Area* is 39 miles above Morgan by river. This area includes the old Waikerie and Ramco settlements. The total area of settlement is 9,276 acres, of which 2,806 acres is first-class irrigable land, growing fruit trees and vines. This area is divided between 136 settlers, and the first allotment took place on the 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. Capacity of plant 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 358 acres of irrigable land, and 2,017 acres of dry land. Blocks have been allotted to 24 settlers, including 11 soldier settlers. The pumping plant consists of two steam units, total b.h.p. 338. Capacity, 4,750 gallons per minute. One hundred and ten acres of irrigable land adjoining, 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 pumping plant is 118 b.h.p. steam plant, capacity of pump 2,000 gallons per minute, total head 118 feet.

The *Moorook Irrigation Area*, adjoining the Kingston Area, contains 5,959 acres of land, of which 1,062 acres is good land suitable for vines and fruit culture. Altogether 1,028 acres of irrigable land have been allotted to 54 settlers, of whom 35 are soldier settlers. First allotment of area, March, 1916. The 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 has been set apart as the Berri Area, and the remainder, 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 Chamber's Creek, a winding waterway. 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 five divisions, the Cobdogla, Nookamka, Loveday, Weigall, and MacIntosh divisions. The Cobdogla Division has 1,834 acres of irrigable land, suitable for vines, fruit, or fodder. Six hundred and twenty-one acres have been allotted to 15 settlers, and 1,210 acres are being used by the Department for nursery, fodder growing, and other purposes. The Nookamka Division, south of Lake Bonney, includes 2,200 acres of irrigable land, 1,241 acres have been allotted recently to 79 soldier settlers, and the balance is ready for allotment in 75 blocks. The Loveday Division will contain about 9,000 acres of irrigable land; constructional work is proceeding on this area, and the blocks will soon be ready for allotment. The Cobdogla Area when completed will accommodate about 1,800 settlers. The pumping plant on the Cobdogla Division at present installed is a 340 b.h.p. steam plant, capacity 16,700 gallons per minute, against a total head of 40 feet. A second pumping plant of two units has been installed on the Nookamka Division at the south end of Lake Bonney. These are a 390 b.h.p. and a 250 b.h.p. steam units with capacities of 9,000 and 4,000 gallons per minute against a head of 100 feet. A second lift plant is being installed on the Loveday Division with a capacity of 6,000 gallons per minute. The completed area of Cobdogla will have five pumping stations, two on the lake, at the north end and the south end, two on the River Murray, and one intermediate from the Low Lift.

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. 7,450 acres of irrigable land has been allotted to 459 settlers, of whom 276 are soldier settlers, and 504 acres are ready for allotment in 35 blocks. Eighty acres of irrigable land are used as a Government Experimental Farm. The first allotment of the older portion of this area took place in January, 1911. The pumping plant consists of 6 units, 3 suction gas and 3 steam units, with a total of 2,202 b.h.p. and a capacity of 33,700 gallons per minute against total heads varying from 50 ft. to 120 ft.

The *Chaffey Irrigation Area* comprises a large area of country adjacent to Renmark at present known as Ral Ral. Survey work is proceeding over 14,000 acres of prospective irrigable land to be divided amongst 850 settlers. A portion of this area, 1,800 acres, is at present under preparation with channel construction and subdivision work. A pumping plant with a capacity of 12,500 gallons per minute against a total head of 50 feet is being installed. The 1,800 acres will soon be ready for allotment in 111 blocks.

The 12,200 acres will be irrigated with a lift of 100 feet, and the preliminary survey work is being carried out as rapidly as possible. The future extension of this area may reach a total of 100,000 acres of irrigable land, with lifts not exceeding 100 feet.

The *Irrigation and Reclaimed Swamp Areas* under Government control on the River Murray below Morgan contain 5,700 acres of high, irrigable, and reclaimed swamp land, allotted to 240 settlers. The former land is irrigable by pumping, and the latter by gravitation. There are also 1,270 acres ready for allotment to 68 settlers, and 5,620 acres under preparation, which will accommodate 256 additional soldier settlers. Pumping plants installed, total 1,500 b.h.p. Capacity $3\frac{1}{2}$ million gallons per hour.

Mobilong and Burdett Areas adjoin Murray Bridge, and contain 586 acres of reclaimed fodder land with 45 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 with 8 soldier settlers, and blocks for 6 more settlers.

The *Jervois Irrigation Area* is in course of construction. It is 15 miles below Murray Bridge, and includes 290 acres of high irrigable and 1,081 acres of reclaimed land. It will accommodate 62 settlers when completed.

The *Woods Point Area* is 12 miles below Murray Bridge, and contains in its total area of 3,726 acres about 1,218 acres of reclaimed land. The area is in course of preparation and will accommodate 54 soldier settlers.

The *Wellington Area* is 18 miles below Murray Bridge, and has an area of over 12,000 acres; of this area about 1,670 acres are reclaimed land. This area will provide for 73 soldier settlers, and is at present in course of preparation for settlement.

The *Myponga Area* is 9 miles above Murray Bridge. This area 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 area has 84 settlers.

The *Pompoota Area* is situated 13 miles above Murray Bridge, and was up till recently used as a Training Farm for prospective soldier settlers, and will now be allotted amongst 38 of the trainees. The area contains 670 acres of fruit and fodder land.

The *Wall Area*, 16 miles above Murray Bridge, has 768 acres of irrigable and reclaimed land. Nineteen soldier settlers are settled on the area, and blocks are available for 11 more.

The *Neeta and Cowirra Irrigation Areas* are 20 miles above Murray Bridge, and include 410 acres of highly irrigable land, and 1,745 acres of reclaimed fodder land. These areas are in course of preparation, and at present 21 soldier settlers have been placed on the blocks. A further 79 settlers can be accommodated when areas are complete.

The *Mannum Area* is about 21 miles above Murray Bridge, and has an area of 1,350 acres. 528 acres will be reclaimed and allotted to 26 soldier settlers in the near future.

Lake Albert. There is a possibility of this Lake being reclaimed in the near future, which will give an area of about 40,000 acres suitable for dairying. The total area, including aforementioned areas adjacent to the River Murray, possible of reclamation or of being brought under irrigation, including 75,000 acres of Lake Alexandrina, is 282,556 acres.

The reclaimed lands consist of peaty soils composed of rich river silt, and are eminently suited 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 Land Board

immediately prior to the land being offered for application. For the reclaimed land an amount is charged sufficient to cover interest on cost of 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.

On the irrigable land, the water rate has been fixed at 60s. per acre per annum for the first four years, after which an amount will be charged sufficient to cover actual cost of supplying water, and interest on pumping plant, channels, etc. 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. On the irrigable lands, each lessee is entitled for the water rate to 24 acre inches per annum, supplied in four irrigations; special irrigations and domestic supplies are supplied at times other than during the general irrigations, at a nominal cost. On the reclaimed lands water is supplied regularly by reticulation from the river.

The Department assists settlers by fencing, clearing, grading, and constructing irrigation channels and tanks. Such improvements are undertaken up to a value not exceeding £30 per acre of the irrigable area in each lessee's block, but before the work is commenced a deposit must be paid equal to 15 per cent. of the Department's estimated value of such improvements. The total cost of the work, less deposit, is treated as a loan to the lessee, and is repayable in twenty equal annual instalments after the expiration of five years, or at any short period if desired by the lessee, current rate of interest being charged. Any lessee is permitted to accept the contract for carrying out his own improvements according to the specifications and estimates of the Department, up to the maximum amount per acre, as mentioned above. Advances can be obtained from the Advances to Settlers Board for the purchase of stock, discharging mortgages, erecting permanent buildings and other improvements, the first £400 being advanced on the fair estimated aggregate value of the settler's lease, and any improvements already made on the holding, and those in course of being made thereon. Any loan beyond £400 would not exceed 15s. in the £1 of the fair estimated value of the improvements already made.

There is, at the present time, no land available for civilian settlers, and it will possibly be two years before soldiers' demands are satisfied. So far as soldiers are concerned, the Department, in most instances, prepares and plants the land for fruit culture prior to allotment, and clears, channels, grades, and plants up to 10 acres of vines.

6. Western Australia.—An Irrigation Act has been brought into force providing 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 connection with fruit, fodder, and potato growing.

7. Murray Waters.—(i) *Water Rights of States.* The relative rights of the States of New South Wales, Victoria, and South Australia to the waters of the Murray River being undetermined, negotiations which had been in progress for some considerable time resulted in the passing of the River Murray Waters Act 1915. Territorially the south bank of the Murray River was the boundary between New South Wales and Victoria. The region of the river itself, up to the point of its entry into South Australia, was wholly within the former State. At the Federal conventions which preceded the establishment of the Commonwealth, the South Australian delegates expressed their fear lest too much irrigation on the Murray and its tributary, the Darling, might impair the navigability of the lower waters of the river. The result was the insertion of a provision in the Commonwealth Constitution, which reads as follows (Section 100):—

“The Commonwealth shall not by any law or regulation of trade or commerce abridge the right of a State or of the residents therein to the reasonable use of the waters of rivers for conservation or irrigation.”

(ii) *Conferences.* After considerable controversy, a conference was held in Melbourne in January, 1911, between the Premiers of New South Wales, Victoria, and South Australia, on the Murray Waters question. The main results of the conference were that Lake Victoria and certain lands adjacent thereto situated within New South Wales

territory should be handed over by New South Wales to South Australia for purposes of a storage basin, and that South Australia might lock her own portion of the Murray at her own expense; no rights of navigation were conceded by New South Wales and Victoria, who would not bind themselves to deliver any quantity of water at the point of intake into South Australia; the upper portions of the river were left free for irrigation.

In 1913 the three States appointed a Board of engineers to carry out investigations, with a view to ascertain means which would lead to a settlement of the whole question of the waters of the Murray and its tributaries. The Board in its report recorded its belief that the interests of irrigation are more important than those of navigation, and that the heavy expense of maintaining the latter is not warranted; suggestions relative to the apportionment between the three States concerned of the river waters and of the works contemplated for their conservation were also made. (See Official Year Book, No. 7, page 510.)

In April, 1914, further discussion took place at the Premiers' Conference in Melbourne, certain resolutions being agreed to by the Prime Minister of the Commonwealth and the Premiers of New South Wales, Victoria, and South Australia. (See Official Year Book, No. 8, page 507.)

(iii) *Constitution.* The River Murray Agreement was signed on 9th September, 1914, and in November, 1915, Acts ratifying the Agreement were passed simultaneously by the Parliaments of the Commonwealth and the three Contracting States. On 31st January, 1917, the Agreement was brought into operation, and the River Murray Commission, consisting of a representative of each of the four Contracting Governments, was appointed.

The Commission is charged with the duty of giving effect to the Agreement and the River Murray Waters Acts.

(iv) *Activities.* The Agreement provides for the construction of the following works:—

To be constructed by the Constructing Authorities for New South Wales and Victoria severally and jointly as may be agreed upon.—The Hume Reservoir; seventeen Weirs and Locks on the River Murray between Echuca and Wentworth.

To be constructed by the Contracting Authority for New South Wales.—Nine Weirs and Locks on the River Murrumbidgee.

To be constructed by the Contracting Authority for South Australia.—The Lake Victoria Storage; Nine Weirs and Locks on the River Murray below Wentworth.

The following works are now in course of construction, in accordance with the designs and estimates approved by the Commission:—

The Hume Reservoir, estimated cost £1,639,000. This Reservoir, which will be created by the construction of a dam immediately below the junction of the Mitta Mitta and Murray Rivers, will have a storage capacity of 1,000,000 acre feet.

Work is proceeding on both the New South Wales and Victorian sides of the River.

Weir and Lock at Torrumbarry, near Echuca.—Estimated cost £120,000 (subject to revision).

The Lake Victoria Storage—Estimated cost £320,000. The Scheme approved provides for the construction of embankments and channels, and the improvement of Frenchman's Creek (the inlet channel to the Lake) and the Rufus River (the outlet channel). The Lake, on completion of the works proposed, will have a storage capacity of 514,000 acre feet.

Weir and Lock No. 9, situated immediately below the junction of the Frenchman's Creek (the inlet channel to the Lake Victoria Storage) and the main stream. Estimated cost £186,898.

Weir and Lock No. 5, near Renmark—Estimated cost £275,000.

Weir and Lock No. 3, near Kingston—Estimated cost £126,328.

The Weir and Lock at Blanchetown (No. 1), which was commenced by the South Australian Government before the River Murray Agreement came into effect, was completed during the early part of the present year, and has been brought into operation. The expenditure incurred on this work amounted to £220,000. All vessels carrying goods passing through this weir and lock will be liable to the payment of tolls at the rate

of 6d. per ton of freight carried, in accordance with the Tolls regulations prescribed by the Commission, in pursuance of Section 7 of the River Murray Waters Act 1915, and appearing in the *Commonwealth Gazette* of 23rd March, 1922.

(v) *Size of Locks.* It has been decided by the Commission and the Contracting Governments that all locks in the River Murray below the junction of that River with the River Darling shall be constructed of a length of 275 feet, and that the length of the locks to be constructed in the Murray above that point and in the River Murrumbidgee shall be 170 feet. It was recognised that the heavier traffic on the River Murray below its junction with the River Darling necessitated the construction of locks of a greater length than was required in connexion with the upstream locks.

(vi) *Finance.* The estimated cost of the whole of the works covered by the River Murray Scheme is set down in the Agreement at £4,663,000, and it is provided that the four Contracting Governments shall contribute thereto in the following proportions:—Commonwealth, £1,000,000; New South Wales, Victoria, and South Australia, each £1,221,000. It is now clear that, owing mainly to the increases which have occurred in the costs of materials and labour since the original estimate was framed, the ultimate expenditure on these works will be considerably in excess of that estimate. The actual expenditure incurred to the end of February, 1922, on the works carried out by the three Constructing Authorities was as follows:—New South Wales, £248,511 13s. 1d.; Victoria, £251,458 18s. 3d.; South Australia, £523,481 18s. 9d.; total, £1,023,452 10s. 1d.

(vii) *Estimated Expenditure during Year 1922–23.* The estimated expenditure during the Financial Year 1922–23 prepared by the Commission and forwarded to the four Contracting Governments in accordance with the requirements of Clause 34 of the Agreement, is £807,000, made up as follows:—

New South Wales—Hume Reservoir, £240,000; Weir and Lock, Wentworth, £60,000; Surveys and Borings, £10,000; total, £310,000.

Victoria—Hume Reservoir, £162,000; Weir and Lock, Torrumbarry, £80,000; Surveys and Borings, £8,000; total, £250,000.

South Australia—Weir and Lock No. 3, £100,000; Weir and Lock No. 5, £20,000; Weir and Lock No. 9, £40,000; Lake Victoria Storage, £87,000; total, £247,000.

The four Contracting Governments will contribute towards this proposed expenditure in the following proportions:—Commonwealth, £173,061 3s.; New South Wales, £211,312 19s.; Victoria, £211,312 19s.; South Australia, £211,312 19s.

(viii) *Gaugings.* All gaugings on the River Murray and its tributaries are made by the three Contracting States, which, in pursuance of an arrangement arrived at with the River Murray Commission, furnishes that body periodically for purposes of the Agreement with the results of such gaugings. Arrangements were made, as a result of recommendation by a Conference of Gauging Officers convened by the Commission, for uniform methods to be adopted in connexion with the recording of gaugings by the three State Authorities, and the returns furnished to the Commission setting out the results of such gaugings. The returns furnished to the Commission during the year 1921 indicated that the total flow of the River Murray at Morgan during that year was 11,257,829 acre feet, while the total volume of water diverted was estimated at 1,250,000 acre feet, of which a portion was again returned to the river.

(ix) *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 is proposed that the construction of all works covered by the River Murray Scheme shall 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 is also provided that the four Contracting Governments shall contribute towards the cost of the Scheme in equal shares, and that all plant required for the construction of works shall 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 have passed legislation giving effect to the amendments proposed. The ratification of this amended Agreement now awaits the passing of the necessary Act by the New South Wales Parliament.