

which is effective in preventing a proportion of the water from running back as the river falls. This will be superseded by the permanent work now under construction, which will include extensive embankments with regulators, to maintain the height of the water in the lake at within two feet of the height in the pool above the No. 9 lock and weir previously referred to. The lake storage will then be some $6\frac{1}{2}$ miles long and 6 miles wide, with a water surface of approximately 30,000 acres, a maximum depth of 24 feet, and a storage of 514,000 acre feet. The River Murray Waters Act empowers South Australia to divert and store in Lake Victoria the flow of the river at the site of the off-take for diversion, "except so much of such waters as under this agreement, New South Wales or Victoria shall have allowed to pass down the river for diversion, supply or use in their respective territories, or as may be required for the purposes of this Agreement at all places below any such site."

The designs for the works have been approved and construction authorised, and one contract has been let and another has been advertised for portion of the embankments required.

LOCKING OF MURRUMBIDGEE OR DARLING RIVER.

The Act prescribes that "at the absolute discretion of the Government of New South Wales," weirs and locks shall be constructed either in the course of the River Murrumbidgee or Darling, as already referred to. After enquiry by a Committee consisting of Messrs. de Burgh, Chairman, Hutchinson, Railway Department, Langwell, Western Land Board, and the writer, into the relative merits of the two proposals, the Government decided to exercise its option in favour of the Murrumbidgee River, and the River Murray Commission has been notified accordingly. On account of pressure of other urgent work in connection with the scheme, the detailed investigation of sites for the locks and weirs on the Murrumbidgee has not yet been undertaken, but will be put in hand in due course.

NAVIGATION WITH LOCKED RIVERS.

The principal shipping interests on the Murray have recently been consolidated under the title of Murray Shipping, Ltd.

The "fleet" controlled by this Company will comprise a considerable number of steamers and barges. Under existing conditions navigation is intermittent, and the vessels are laid up in ordinary seasons for long periods when the river is too low to permit of navigation. With a navigable river

over 1,000 miles long, from Echuca to Murray mouth, and extending 240 miles up the Murrumbidgee, and with the great irrigation developments that must follow upon the use of the regulated flow of the river, it is to be anticipated that there will be an increase in shipping activities. Water carriage is cheap, and even allowing for the quantity of freight that will be carried upon existing and projected railways tapping the Murray basin, it seems reasonable to expect that the river will be used to an increased extent for the carriage of such articles as wool, wheat, dried fruit, timber, etc., where quick transport is not essential, especially if improved facilities are provided at Murray mouth. The question of markets must, however, be also considered, and no forecast can at present be attempted of the revenue to be expected from river tolls, nor how far this will go towards meeting interest and depreciation charges, after providing for operating expenses.

EXISTING IRRIGATION DEVELOPMENT IN THE THREE STATES.

Before referring to the increased development in irrigated agriculture which will be possible when the works covered by the River Murray Waters Agreement have been completed, it may be of interest to briefly review what has already been done in this direction in the three States interested.

New South Wales.—The only State irrigation schemes are:—

- (1) Curlwaa, supplied by pumping from the Murray River.
- (2) Hay, supplied by pumping from the Murrumbidgee River.
- (3) Murrumbidgee Irrigation Scheme, supplied from the flow of the Murrumbidgee River, as regulated by Burinjuck dam, and the unregulated flow of the Tumut River.

The Curlwaa area, near Wentworth, comprises 10,590 acres, of which 1,405 acres are irrigable. This area, which was established under an Act passed in 1890, languished for many years, but is now a thriving and prosperous settlement, which will be extended so soon as water is available from the Upper Murray Storage.

The Hay area includes 4,290 acres, of which 1,029 acres are irrigable. The principal industry is dairying.

The Murrumbidgee areas will probably include ultimately from 200,000 to 250,000 acres under irrigation, in addition to dry lands. The irrigable area taken up at the present time is between 40,000 and 50,000 acres. The principal industries are

fruitgrowing and dairying. The first farms were allotted in 1912; 1,500 farms for returned soldiers are being provided for on these areas. The total expenditure in connection with this scheme, including the construction of Burrinjuck Dam, Berem-bed Weir, canals and works generally, land resumption, construction of factories and township works, maintenance and operating charges, and assistance to settlers, has been over £4,000,000.

In addition to the above there are a number of small areas irrigated by private persons, with water pumped from the Murray and its tributaries.

Victoria.—The annual reports of the State Rivers and Water Supply Commission show that in 1914-1915 there were 324,345 acres under irrigated culture.

Cereals	74,658 acres
Lucerne	71,217 "
Sorghum and other annual fodder crops	37,759 "
Pastures	81,463 "
Vineyards, Orchards and Gardens	28,666 "
Fallows	13,368 "
Miscellaneous	17,214 "

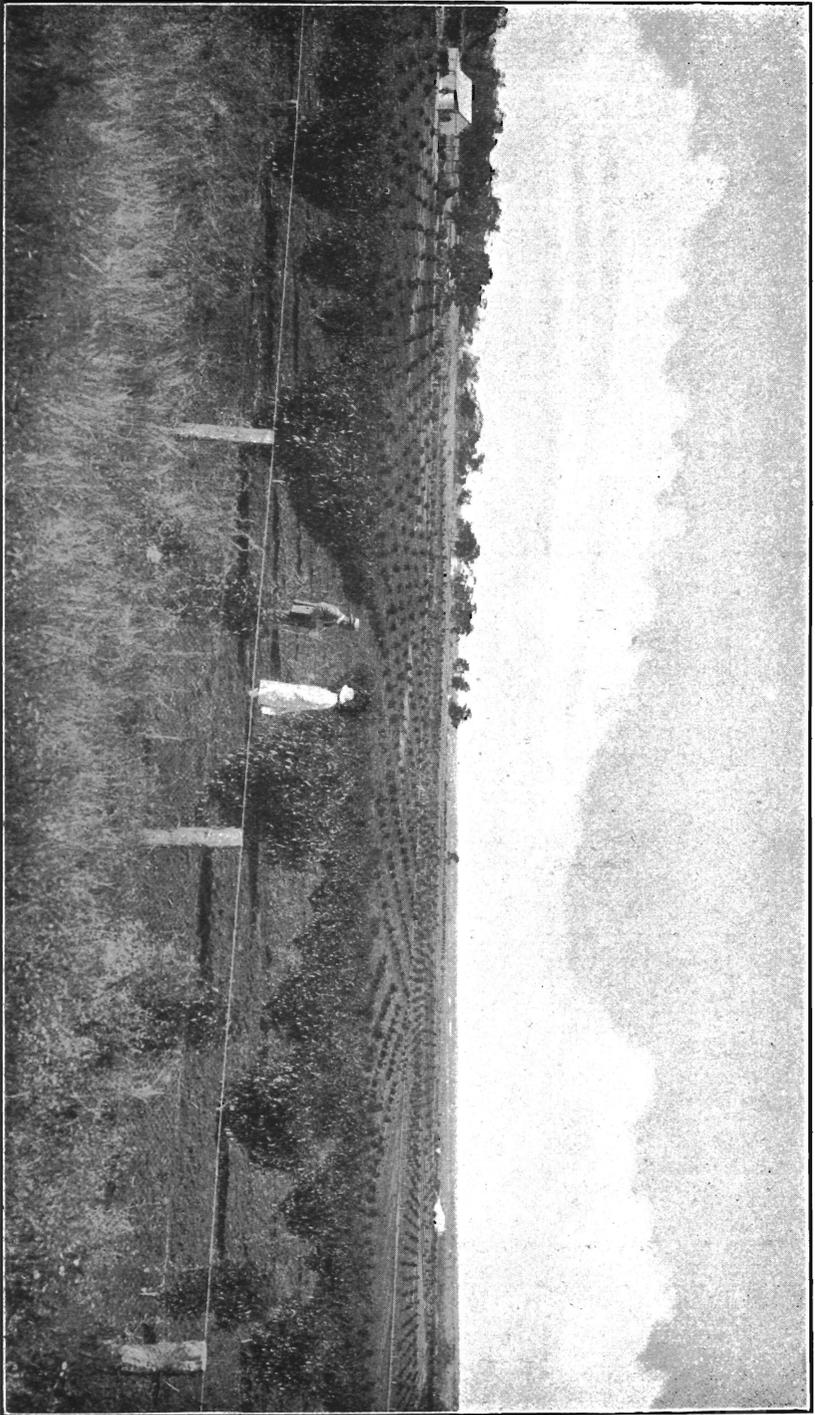
The 1914-1915 season was a very dry one, and the area under irrigation decreased during the following wet seasons, as shown in Appendix "A."

With the exception of a few comparatively small areas, such as Bacchus Marsh, Werribee, etc., the whole of the water used for the above is drawn from the River Murray or its tributaries, the Goulburn State Works contributing the largest share, viz., 185,185 acres in 1914-1915, and 75,614 acres in 1917-1918.

It may be noted that the area irrigated for vineyards, orchards and gardens increased to 38,246 acres in 1916-17.

The loan liability of the State at 30th June, 1918, is given as £9,338,953, of which £1,237,729 was for free headworks, and a large sum for expenditure written off, leaving a balance of £5,874,532 for which those benefited were liable to pay interest.

South Australia.—Mr. McIntosh, Director of Irrigation, has furnished particulars, given in Appendix "B," with regard to the irrigation areas in South Australia to June, 1918. The principal of these are situated along the valley of the Murray, from which water is pumped to levels carrying from 10 to 120 feet. It will be seen from the statement that, including reclaimed swamp lands, a total area of 27,642 acres is irrigated for fruit and fodder crops, while considerable extensions are in contemplation at Cobdogla, Berri and elsewhere.



5.—Berril Irrigation Area, South Australia (2 years' growth).

Attached to the irrigation districts and reclaimed lands are considerable areas of dry land.

IRRIGATION DEVELOPMENT POSSIBLE FROM RIVER MURRAY WATERS SCHEME.

Omitting development possible from the tributaries of the River Murray, it will be seen that from the river itself the following is the estimated quantity of water which will be available during the irrigating season of eight or nine months in all ordinary years:—

	Acre Ft.
New South Wales (share of regulated flow at Albury)	120,000
Victoria (share of regulated flow at Albury)	120,000
South Australia (at the outlet from Lake Victoria)	114,000

The three States will therefore be in practically the same position with regard to the water available for irrigation purposes. Portion of this water will be required for locking purposes, portion will be lost by evaporation and seepage, portion will be required for stock and domestic supplies to riparian holders. The balance will be available for irrigation development.

Adopting for approximate estimate purposes the assumptions given on page ??, the following will then be the position, allowing for an irrigating season of 9 months in each year.

TABLE SHOWING APPROXIMATE AREAS WHICH CAN BE IRRIGATED FROM WATER SUPPLIED UNDER THE RIVER MURRAY SCHEME.

	New South Wales.	Victoria.	South Australia.
	Acre feet.	Acre feet.	Acre feet.
1. Gross volume available for nine months	1,080,000	1,080,000	1,026,000
2. Volume available after providing for riparian and lockage requirements, evaporation and seepage, nine months	916,100	916,100	870,000
3. Losses before delivery to irrigable lands, 40 per cent., for nine months	366,440	366,440	348,000
4. Nett volume available for nine months	549,660	549,660	522,000
5. Area which can be irrigated, allowing 2 acre feet per acre	274,830	274,830	261,000

This is equivalent to an allowance of about 137 acres per cusec, based on the volume delivered at Albury or Lake Victoria.

While the above figures of area should, of course, be taken as a rough approximation only, they give an idea of the great development in irrigated agriculture, which will be rendered possible by the River Murray Scheme.

Victoria is already using portion of her share at Swan Hill, Nyah, Kerang, Cohuna, Mildura, Merbein and elsewhere. The total diversion from the Murray, exclusive of tributaries, by Victoria for State irrigation schemes and Mildura, in 1918-19, was 276,600 acre feet.

The South Australian settlements at Renmark, Berri, Cobdogla, Moorook, Kingston, Holder, Waikerie, Wall, Mypolonga, Pompoota and other places are all supplied from the Murray River. The total diversions from the Murray River in 1918-1919 for State and private irrigation settlements were about 53,000 acre feet.

Both Victoria and South Australia are using much more irrigation water than New South Wales, but will still have considerable volumes available for future development.

Apart from small areas irrigated by private riparian holders, and for stock and domestic supplies to some Trust areas supplied by channels off-taking from the Murray, New South Wales has not so far used any of her share, except at Curlwaa, where the diversion is trifling.

At this stage it is not possible to state where the balance of the 120,000 acre feet (New South Wales share of the regulated monthly flow at Albury) will be utilised. Surveys have been made for a gravitation scheme, taking off from the Murray River at Bungowannah, or alternatively near Corowa, or near Barooga, to supply a large area near Berrigan. Surveys have also been completed for several pumping schemes above the junction of the Murrumbidgee River, and further surveys have yet to be made of other areas before a decision is arrived at. The investigations will be pressed on with a view to determining in good time which areas are to be developed on the New South Wales side when the Upper Murray Storage becomes effective in assuring a regular supply of water in the river. It is too early yet to forecast the purposes for which the water will be utilised; but it is safe to say that a large proportion will be used for the growth of fruit, for which there are considerable areas of very suitable country adjacent to the river on the New South Wales side.

As an example of the returns to be expected from fruit-growing under irrigation, the following particulars are furnished concerning the returns from some of the older settlements:—

The Mildura Settlement was established about 1885. Including Irymple, the area of fruit planted is about 10,220 acres,

in addition to 805 acres of lucerne and other crops and house gardens.

The Merbein Settlement adjoining Mildura was established many years later. The area planted includes about 5,150 acres of fruit and 290 acres of lucerne.

In connection with these two settlements figures have been furnished which show that the approximate gross value, f.o.b. Melbourne, of last season's fruit crop, was over £800,000, or at the rate approximately of between £50 and £60 per acre. The crop was principally dried fruit, currants, sultanas and laxias predominating.

The Renmark Irrigation Settlement was established in 1887. Mr. Taylor, Editor of the "Murray Pioneer," has furnished me with the following information. The area planted amounts to 5,500 acres. The annual value of the fruit output is approximately between £140,000 and £150,000. The estimated value of the 1917-1918 crop was £153,000.

At Curlwaa, where the area planted to 30th June, 1918, was 776 acres, of which 600 acres were in bearing, the gross value of the returns from the Settlement last season was about £27,000. This includes returns from a small area planted to crop.

SUMMARY OF PROGRESS TO DATE.

It is now nearly 2 $\frac{3}{4}$ years since the River Murray Waters Act came into force, and the progress with the Murray Waters Scheme may be briefly summarised as under:—

Upper Murray Storage.—Site for dam selected after several years' investigation, during which 25 sites were tested. Contour surveys for the storage completed, and the design for the dam prepared, and construction authorised. Preliminary work commenced at site.

Locks and Weirs above Wentworth.—Surveys of the river in progress by parties working from Echuca downstream, and from Wentworth upstream, in addition to parties engaged on base line surveys, embracing the whole 550 miles of river on both banks. The construction of the first lock and weir below Echuca, that at Torrumbarry, authorised and in progress. The sites for the remaining locks and weirs not yet determined.

Lake Victoria Storage.—Construction of the necessary works authorised and in progress.

Locks and Weirs Below Wentworth.—Surveys completed and the sites for the nine locks and weirs determined. Construction of the lock and weir at Blanchetown nearing completion. Construction of locks and weirs Nos. 2, 3 and 9, in order above Blanchetown, authorised.

Value of Work Authorised.—The value of the above works, including land resumption, authorised by the River Murray Commission, amounts to over £2,500,000. This is in addition to the cost of the Blanchetown lock and weir, the construction of which was commenced before the Act came into force.

CONCLUSION.

The object of the present paper is to give a general sketch of the progress made with this great scheme, the development of which will be of the highest importance to the three States interested, and to the Commonwealth. The description of the works has been limited to such an extent as necessary for the proper understanding of the subject with the anticipation that fuller details will be supplied at a later stage by the Engineers responsible for their design and construction. The author's thanks are due to Mr. J. G. Stewart, Engineer-in-Chief, and Mr. S. McIntosh, Director of Irrigation, South Australia, for photographs and information; to the Hon. L. E. Groom, President of the River Murray Commission; and Mr. R. T. McKay for the loan of lantern slides; and to Mr. J. E. Slade for assistance in the preparation of the Paper.