

when the temperature is mild and the rain discharge distributed over comparatively long periods of time. Of the rain water that does find its way to the river channels, a portion only is carried by them to the sea ; much of it passes through drifts and possibly rock fissures in the river beds, to travel to its ultimate destination by underground channels. In the rivers of the Murray system a considerable proportion is dissipated by flowing off into anabranches, effluent creeks, lakes, and lagoons, and being there evaporated. To determine fully the hydrographic conditions of a river it is necessary, therefore, that gaugings be made at more than one point of its course ; and it is very desirable—where gaugings are made with a view to specific diversion and utilisation—that they be as near to the intended point of offtake as possible. The value of stream-gauging increases with the length of time over which it is extended ; and it is important that here in Australia there should be some uniformity of system, both of observing and recording. This can only be attained by entrusting the work to one authority, or by proper concert among the States. A complete compilation of results of the gaugings of all the important streams that contribute to the flow of the Murray should be published periodically and made readily available to the section of the public specially interested.”

**Importance
of
Stream Gauging.**

POLLUTION OF RIVER WATERS.

As water is a vehicle for the spreading of infectious diseases, it is a matter of the greatest importance that the streams from which public water supplies are drawn should be pure. The health of the people is of the first concern, and it is, therefore, essential that the pollution of streams by the discharge of sludge from mining operations, or by the discharge of sewage from towns or dwellings along the banks of the rivers, should be guarded against. At the head of the Murrumbidgee, Murray, Tooma, Swampy Plain, Mitta, and Kiewa Rivers, mining by sluicing has been carried on for a number of years ; in fact, many of the towns owe their existence to the extensive working of alluvial deposits. Kiandra, in the early sixties, contained a population of many thousands of miners, and Tumberumba to-day is in a great measure supported by those engaged in this occupation. The miners may be said to have established some kind of prescriptive right to use the watercourses of the country as common drains, but it cannot reasonably be contended that any body of men can acquire a prescriptive right to carry on their industry, however profitable, at the expense of the health and well-being of the community. In America, instances have occurred

**Effects of
Mining by
Sluicing.**

where mining by sluicing has been entirely stopped, owing to the strenuous opposition of the people using the water for domestic purposes. Dealing with the question of the pollution of streams, the "Law of Waters," by Messrs. Coulson and Forbes, contains the following passage:—"A right to pollute the waters of a natural stream is an easement within the prescriptive Act, and may be acquired, like any other easement, by user; but there can be no prescriptive right to

Plate 38.



SLUICING CLAIM.

pollute a stream in such a manner and to such an extent as to be injurious to public health." Plate 38 shows a mining claim on one of

**Suggested
restrictions.**

the streams that flow into the Mitta. There are methods of precipitating the sludge, and thereby minimising the evil complained of by the residents of Albury, Corowa, and other places. This was one of the special questions remitted to the Murray River Commission for inquiry and report, and the Commission is of opinion that "in the issue of any future leases of land for mining, there ought to be a condition that no water used for washing auriferous earth, or for treating any auriferous matrix, shall be liberated after use containing in suspension solid matters of more than a fixed percentage, to be determined by competent expert authority. A provision should also be inserted in an amendment of the Mining Statute, imposing the like restriction on the holders of claims under the mining by-laws."

ARID AREAS.

In the centre of the Australian continent there is an immense area of 780,544,000 acres with a rainfall of less than 10 inches per annum, the area between the 10 and 20 inches rainfall lines is 539,584,000 acres, and this includes a very considerable portion of the Murray Basin.

Generally speaking arid regions are taken to include all areas with an average annual rainfall of less than 20 inches. In New South Wales the whole of the basin west of Collerendabri in the north and Tocumwal in the south would be included in the arid region, and this area would be no less than 110,000,000 acres. In Queensland the whole of the Murray Basin, with the exception of a small area in the extreme north-east, near the Dividing Range, would be termed arid. In South Australia the average rainfall for the basin would not be more than 10 inches per annum, while in Victoria there is a considerable area of the northern and western portions of the State with an extremely low rainfall. Included in this area

**The Mallee
Country of
Victoria.**

is the mallee country of Victoria, which comprises an area of 11,500,000 acres, and was looked upon some years ago as almost desert land. Modern farming appliances have solved the problem of removing the timber at a comparatively trifling cost, and the Crown has leased the lands on very moderate terms. It is capable of being cultivated in a less expensive way than the soil of any other portion of the State, and the manner in which the land responds to the rainfall is little short of marvellous. In 1883 the Victorian Parliament passed the Mallee Pastoral Leases Act, under which the mallee was divided into "blocks," to be used for pastoral purposes only, and "allotments," for the growth of cereals. The latter were situated on the southern and eastern fringe of the mallee, extending from the South Australian border through Warracknabeel, Birchip, and Quambatook, to Swan Hill. The area originally set aside as "blocks" was 9,407,760 acres, and as "allotments," 2,127,740 acres. To meet the demands of the settlers the area in the allotments was increased, until at the present time there are 4,000,000 acres occupied by farmers having the right to cultivate their holdings. During the currency of the lease the occupiers, and any of their children over eighteen years of age, have the right to either select out of the holding, or, under the perpetual leasing system, retain permanent possession of areas ranging from 640 to 1,600 acres, according to the classification or value of the land. The Land Act of 1900 provides that first-class lands be valued at 20s. per acre, second class at 15s., third-class at 10s., and fourth-class at 5s. per acre. The area under crop is estimated at about 900,000 acres, and there are 2,100 cultivators. The population of the mallee is 16,000, exclusive of the



GOVT. PRINTER
N.S.W.

1. TRAGOWEL PLAINS IRRIGATION TRUST, VICTORIA. WEIR ON SERPENTINE CREEK.
2. COLIBAN WATER SUPPLY, VICTORIA, OVERSHOT ON BACK CREEK SYPHON.
3. DUMBULBULANE WEIR. BROKEN CREEK VICTORIA.

irrigation colony at Mildura. An irrigation scheme to the mallee is not possible, as sufficient water is not available; but the Government of Victoria propose to continue a channel from the Waranga Basin to the mallee, in order to provide a stock and domestic supply for the settlers. Within the last few years the mallee has been considerably developed, towns have sprung up, and railways have been constructed where no sign of life had previously existed. The great drought, in which the mallee settlers suffered terribly, has told its tale, yet the farmers have clung to the land with great tenacity, in the hope of a change of seasons.

Plate 40.



WAKOOL RIVER, N.S.W.

In New South Wales and Queensland the arid area consists of open grazing lands, but the basin of each of the rivers that flow into the Darling possesses certain peculiarities of topography, climate, and water supply. It is not to be assumed that the whole of the arid portion of the States is irrigable, and, even if water were available in large quantities, there is much of the land of a heavy clayey nature, entirely unsuitable for irrigation. On the other hand, it is highly probable that by conserving the water, and making the best use of the resources of the artesian basins of Queensland and New South Wales, the cultivable area will be increased to a marked degree.

In the United States of America, a country in many respects similar to our own, it has been found that the land laws of the humid east were not applicable to the development of the west, and Act after Act has been passed with a view of meeting the conditions of settlement and the climatic conditions of the country. In a comprehensive measure recently passed by Congress, provision has been made for a reclamation

fund to be derived solely from the proceeds of the disposal of the public lands in the arid and semi-arid regions. The limit is set to expenditure, and the Bill specifically limits all work to the amount of the fund. A notable feature in the Bill is that it provides for a continued increase of the fund through the returns to it of the proceeds of the disposal of lands when reclaimed. This allows a gradual increase and steady development of the country along well-regulated lines, and works can be slowly constructed for storage and water supply, and the land settled by a steady influx of population as the canals proceed to give them water for irrigation purposes. The total area of arid lands in the United States is about 600,000,000 acres, and it is estimated that 100,000,000 acres can be redeemed by irrigation through the utilisation of stream waters. The highest priced and most productive of farm lands in America are in the arid region, and the largest yield of nearly every crop has been obtained by means of irrigation.

**Reclamation
of Arid Lands
in America.**

IRRIGATION IN VICTORIA.

The activity displayed by our Victorian friends in connection with the conservation and distribution of the waters of the Murray Basin is in striking contrast to the policy adopted in New South Wales. We have been collecting data in this State for a number of years, but to see the practical side of irrigation in the Commonwealth one must turn to Victoria. Where it has been possible in that State to provide

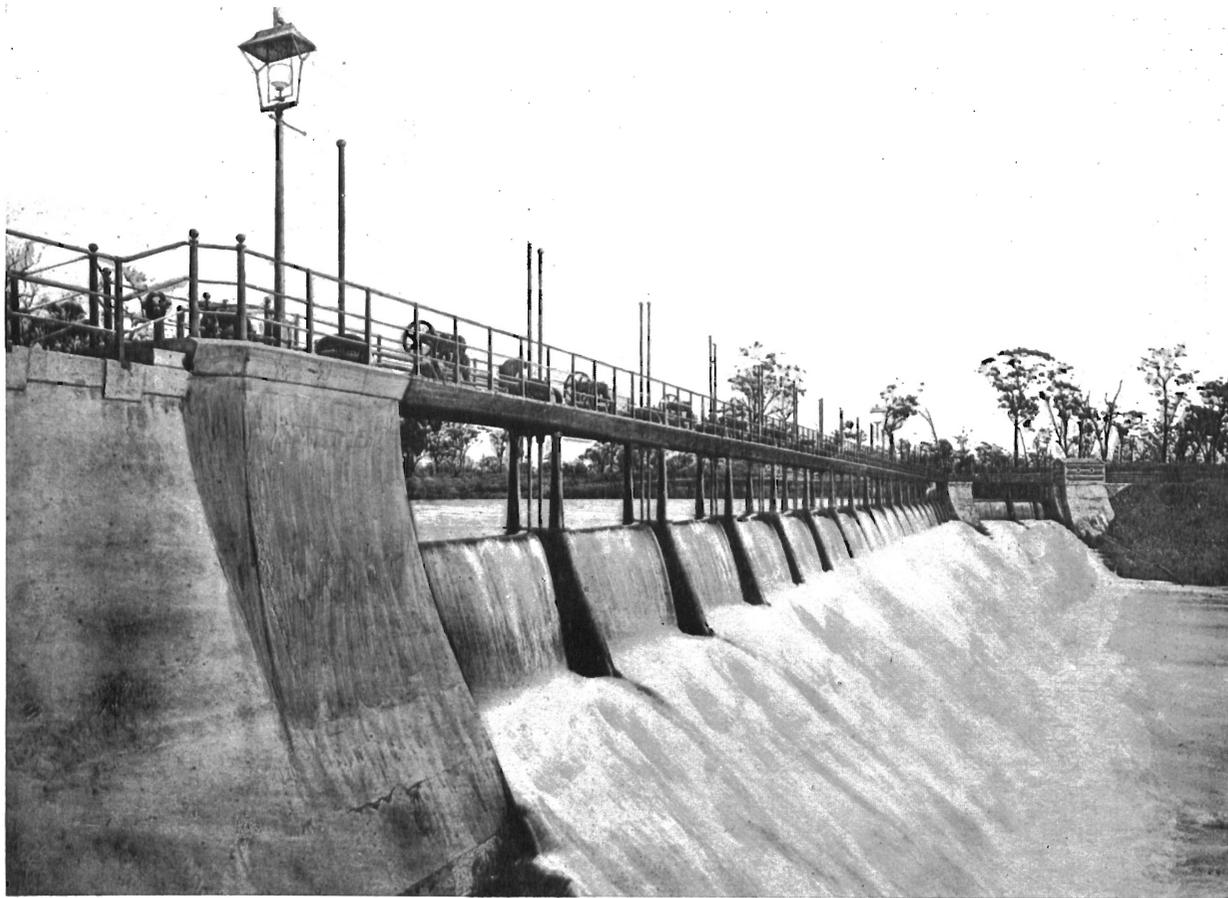
**Irrigation
Trusts.**

water for irrigation purposes this has been done, but where the volume is inconsiderable, and not sufficient to provide for an adequate supply for irrigation, the authorities have formed what are termed Water-works Trusts, which supply water for stock and domestic purposes for the settlers. Altogether there are twenty-eight Trusts, viz., twenty-one Irrigation and seven Water-works Trusts, and the area commanded is 2,640,000

**Goulburn River
National
Works.**

acres, of which 276,000 acres are irrigated. The Goulburn national works comprise a weir on the Goulburn River, about 8 miles above the town of Murchison, and 20 miles of main channel, regulators, offtakes, &c. The weir (Plate 41) raises the summer level of the river about 45 feet, and provides an available storage of 670,000,000 cubic feet. The waterway of the weir is occupied by twenty-one flood-gates, each 20 feet horizontally, by 10 feet vertical. Each gate weighs 7 tons, and is worked by screw gearing, the motive-power being obtained from the river itself. An electric-lighting plant is provided for convenience of night-work during floods. The total cost of the works and land

Plate 41.

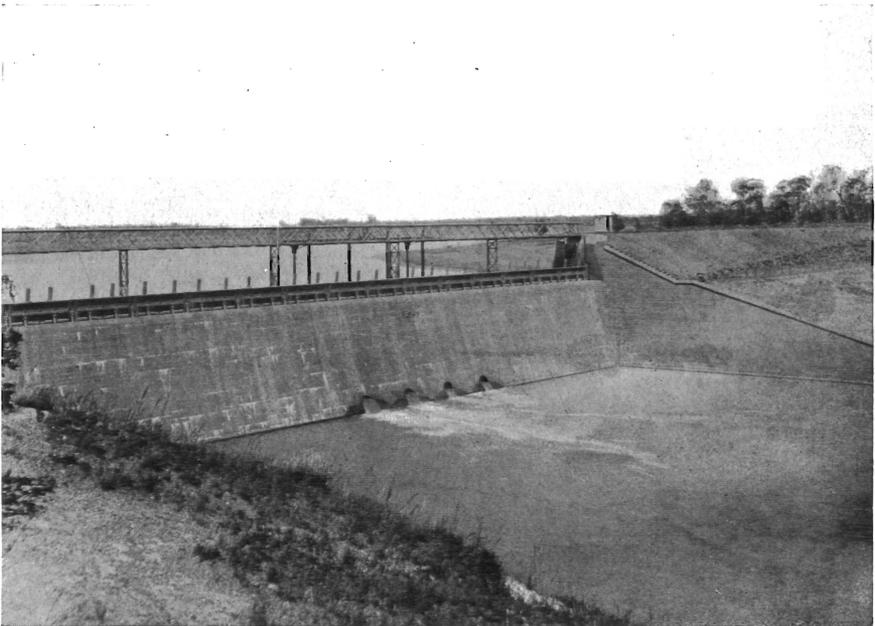


VICTORIAN NATIONAL WORKS. GOULBURN WEIR.

resumption has been £465,000. The western channel, which supplies the Rodney Irrigation Trust, is 110 feet wide, and its capacity is 103,000 cubic feet per minute. The Rodney Irrigation Trust comprises an area of 277,545 acres, and water is supplied to 600 irrigationists, who are engaged in a system of farming and intense cultivation. During the great drought, when large areas of valuable country in New South Wales remained almost like a desert, the Rodney farmers were fattening stock for the Bendigo and Melbourne markets, and supplying the squatters of Riverina with lucerne and other fodder for their starving stock.

**Rodney
Irrigation
Trust.**

Plate 42.



LAANECOORIE WEIR LODDON RIVER, VICTORIA.

It was on the Lower Loddon that the failure of crops from lack of moisture first drove the settlers to resort to artificial watering. Farmers—generally with the aid of steam-pumps, but sometimes by gravitation where the conditions were suitable—watered their wheat-fields before the subject of irrigation had been taken up as a public question by the Government of Victoria. At the present time nearly the whole of the plain country has been formed into Trusts, and supplied with water for stock and domestic supply, and for irrigation purposes. The Loddon national works comprise a regulating reservoir on that river at

**Loddon
District.**

Laanecoorie (Plate 42), and two other weirs for diversion at Bridgewater, and at the effluence of the Kinypanial Creek.

**Loddon
National
Works.**

The Laanecoorie weir is a compound structure, the portion in the river being an overshot weir of concrete masonry, with a row of wrought-iron automatic gates. The remainder is in the form of an earthen embankment. The length of the masonry weir is 320 feet, and the earthen extension 700 feet. There are four 36-inch outlets, controlled by valves. The impounded water extends some $5\frac{1}{2}$ miles up the river valley, and the capacity of the reservoir is 610,000,000 cubic feet. The total cost of the work has been £133,000, of which £47,000 was for land resumption. The Bridgewater weir (Plate 43) forms a cap to a natural barrier of basalt rock crossing the river at this point. Its function is to divert water into the Bridgewater channel, which supplies the Bullock Creek. This weir was constructed by the Loddon United Water Trust, but was subsequently taken over as a national work by the Board of Land and Works after the Trust District had

Plate 43.



BRIDGEWATER WEIR, LODDON RIVER, VICTORIA.

been greatly reduced by the formation of Irrigation Trusts. The Bullock Creek channel (Plate 44) is a very extensive cutting, which has been excavated through solid basalt rock. It is an overwhelming proof of the popularity of irrigation in Victoria when canals

are constructed through such difficult country, at considerable expense. The Kinypanial weir (Plate 45) is a timber structure on the Loddon River, near the effluence of the Kinypanial Creek. Its function, in conjunction with the head sluice and cutting that supply the creek, is

Plate 44.



BULLOCK CREEK CHANNEL, VICTORIA.

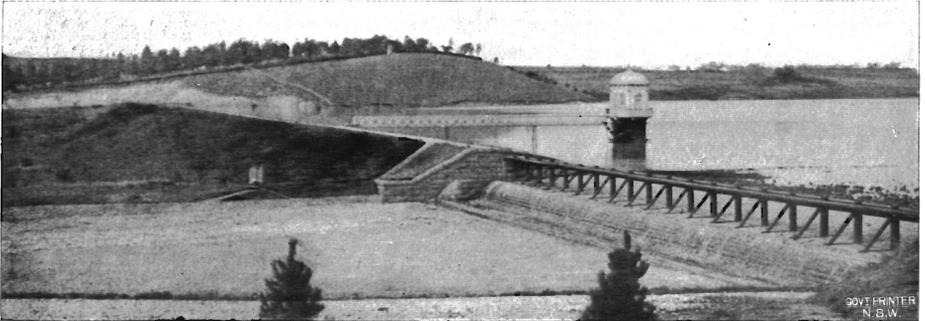
to regulate and control the quantities of water sent into it from the river. By the Kinypanial Creek are sent the supplies to the East Boort and North Boort Irrigation Trusts, which comprise an area of 32,340 acres. A considerable portion of the water required for the Loddon United Water-works Trust, which embraces an area of 844 square miles, is also supplied and controlled by the Kinypanial weir.

The Upper Coliban has played an important part in the development of the mining, manufacturing, and agricultural resources of the city of Bendigo, the boroughs of Castlemaine, Chewton, Eaglehawk, Raywood, and the towns of Taradale, Fryers, Maldon, Huntly, and Sebastian. A considerable area of orchard and farming land is under irrigation, and the possibility of extensions, both in respect of suitable soil and command of water, is great, and the profits of the industry are such as to warrant the belief that horticulture and viticulture, combined with fruit-drying and fruit-preserving, must

rank among the staples of the Bendigo, Castlemaine, and adjacent districts. The water supply for the above-mentioned districts is drawn from the Malmsbury (Plate 46) and Upper Coliban reservoirs, which have been constructed at great cost, and provide an efficient and never-failing scheme of water

**An efficient
Water Supply.**

Plate 46.



MALMSBURY RESERVOIR, VICTORIA.

supply. Besides the two principal reservoirs on the Coliban River, there are twenty-five subsidiary reservoirs, 284 miles of main and branch channels, 265 miles of main and reticulation pipes, together with flumes, bridges, and other works. The scheme has cost to date £1,250,000. The embankment of the Malmsbury Reservoir is of earth, 1,727 feet long, and its maximum height is 60 feet. It is scarcely necessary to point out the importance of an adequate water supply being provided for a large mining centre. Bendigo is fortunate in this respect, and water is supplied to the Bendigo mines at a cheaper rate than to any other mining district in Australia, thereby enabling low-grade ores to be treated. Water for sluice mining is supplied from these works at merely nominal charges, and is sometimes given free.

**Cheap Water for
Mining Purposes.**

The Kow Swamp National Works are very extensive, and comprise an intake and regulator, at the effluence of Gunbower Creek from the Murray River, for diversion into a natural lagoon, known as Kow Swamp. Plate 47 shows the diversion channel a short distance from the Murray off-take. The Kow Swamp Reservoir is capable of storing 1,780,000,000 cubic feet, available for summer use. A channel is carried round the swamp from Taylor's Creek to join the Macorna channel which issues from the storage at its north-eastern point, supply being thus available both from the Murray direct and from the storage. The Macorna channel reaches the Loddon at a point about 12 miles south

**Kow Swamp
National Works.**

of the town of Kerang, crosses the river by a wrought-iron siphon, and terminates at a total distance from the Gunbower intake of $44\frac{1}{2}$ miles. It has a carrying capacity of 10,000 cubic feet per minute. The Victorians have conceived some excellent ideas with regard to water conservation, and it might be mentioned that when there is very little water in the Lower Loddon, its river channel is supplied from the Murray by means of the Kow Swamp Works. The following trusts have been supplied from the Kow Swamp Works, viz. :—Gunbower West, Kerang East, Marcorna North, Dry Lake, Kerang South, Twelve-miles, Wandella, and Marquis Hill. The Kow Swamp National Works have cost about £200,000. Plates 48 and 49 show a few of the weirs that have been constructed on the Broken River and Broken Creek in the Upper Goulburn Valley. Plate 48 shows Gowan Gardie weir, which is a concrete structure on the Broken River, about 15 miles from the town of Shepparton. It is

**Various types of
Victorian Weirs.**

Plate 47.



KOW SWAMP WORKS: DIVERSION CHANNEL FROM THE MURRAY.

used for the diversion of water for the Shepparton Waterworks Trust. The flow of the water in the channel is regulated by means of a gate in the head sluice. The weir is furnished with a compensation notch, through which the supply passes down the river. The Katandra weir is