12. Irrigation and Water Supply in Victoria.

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PART I. THE BEGINNINGS OF WATER SUPPLY.

One hundred years ago, it was the presence of fresh water in the Yarra River above the falls, where Queen's bridge now stands, that determined the site of Melbourne; and, during the century that has followed, it has been the presence or absence of water that has governed the location of most of the country towns, and limited the settlement of rural lands.

The first half dozen years of Victoria's history saw an amazing influx of pastoralists with their flocks, and the occupation of practically all the well-watered portions of the State—then known officially as the Port Phillip District.

Water Supply Pioneers.

By 1840 settlement was already extending into the Northern and Wimmera Plains well beyond the regions of perennial streams and assured water supplies, and it was not long after this that the squatters in these regions began to block the more important north flowing streams in order to turn portion of their flows down the effluent watercourses that normally carried water only in flood time.

To some extent these waters were used to irrigate natural pastures, but their chief use was to provide drinking water for stock along the streams.

The earliest of these water supply pioneers were Dr. Atkinson of Boort, who turned the Loddon River down the Kinypanial Creek in the early forties, and Samuel Wilson of Longerenong, later Sir Samuel Wilson, the University benefactor, who turned the Wimmera River down the Yarriambiack Creek.

The Learmonths, near Buninyong, were probably the earliest irrigators, when, during the pastoral depression of 1842-3, they utilized the liquid by-products from their extensive boiling-down works to water a small area of cultivated land with surprisingly good results.

It was not long after this that the possibilities of irrigation generally in Victoria were being urged by engineers, and others with Indian or Egyptian experience.

The discovery of gold, however, in 1851, turned attention away from rural water supply, and, although the demand for agricultural products was greatly stimulated by the rapidly increasing population, the Government for some time to come was fully occupied in providing water supplies to the numerous thriving goldfields of the state. With these works in hand, the Government had no funds that could be made available for the supply of water to agricultural districts, either for domestic and stock use or for irrigation purposes.

Early Irrigators.

Enterprising landowners, however, in various parts of the state, began to realize the possibilities of irrigation, and in 1859, when the infant colony was only 25 years old, the first serious attempt at irrigation on a commercial scale was made.

This was on the property of Sidney Ricardo, a landowner near Heidelberg, who was also one of Victoria's earliest legislators.

Ricardo's scheme comprised a steam pumping engine which lifted water from the Yarra River into a large excavated storage on the hillside whence it was distributed over his farm of 185 acres through a complicated system of pipes.

Unfortunately, although Ricardo later abandoned the costly pipe system for the cheaper furrow method of irrigation, his scheme was not a financial success, and all that remains to-day is the storage reservoir on the top of the hill.

Ricardo's venture was closely followed by an elaborate irrigation scheme established in 1860 at Adelaide Vale, on the Campaspe River, for Messrs. Elms and Bladier, and a number of lesser schemes on various streams throughout the State.

A National Question.

Water supply, by 1860, was becoming a question of national importance, and in connection with the Victorian Exhibition of that year, the Government of the Colony offered valuable money prizes for essays on, amongst other subjects, Agriculture and Water Resources.

The winner of the Agricultural Prize was William Story who saw both the value of irrigation, and the imperative need for water storage to conserve the winter flows of the streams for summer use. He wrote that irrigation was predestined to be a prominent feature in Australian development.

Frederick Acheson, who won the Water Resources Essay, was not so keen of vision. He projected a system of channels with feeders heading from the northern streams of Victoria, to supply the waterless plains between them, but he did not foresee the need for conserving the river flows in storages, and his channels would have been subject to all the fluctuations in flow of the rivers themselves. In times of drought they would have failed altogether.

North-Western Canal Project.

Shortly after this, one of our leading pioneers, Benjamin Hawkins Dods, came forward with a most ambitious project for the construction of a great canal which was to benefit 15,000,000 acres in northern Victoria by providing irrigation in summer, drainage in winter, and cheap water transport for the resulting produce.

The canal was to start at Murchison on the Goulburn River and extend right across northern Victoria and down to the sea at Portland.

Dods, with W. McCulloch, C. M. Inglis, and Hugh Parker, formed the Grand Victorian North Western Canal Company to advance this project. The company's proposal was that it should receive 3,000,000 acres of the reclaimed land as a grant. A few years later Mr. Hugh McColl, of " Canawl " fame, often referred to as the Father of Irrigation in Victoria, became secretary to the company and enthusiastically took up Dod's proposal.

Although the company's scheme did not eventuate, it is interesting to remember that the present course of the Waranga-Mallee channel, as actually constructed, agrees, as far as it goes, remarkably closely with the route proposed by the company for its main canal.

Supplies to Northern Plains.

The Macpherson Grant *Land Act of* 1869 was at this time in operation, and settlers were pouring into the Northern Plains.

At first, 1870 to 1875, rains were plentiful and all went well. Then came the 1877 to 1881 drought with its devastating losses. This led to the first big step by the Government—the appointment of Messrs. Gordon and Black, a former Chief Engineer of Water Supply and the Assistant Surveyor General, to report on the water supply and irrigation of the Northern Plains—for it was by this time clearly realized that without artificial means of water supply and irrigation these areas could not be successfully occupied.

Messrs. Gordon and Black carefully examined nearly the whole of the northern districts and furnished a number of separate reports—twelve dealing with domestic and stock supplies and two with irrigation. The leading principles of the schemes suggested were that the waters of each river should, as far as possible, be utilized within its own basin; that summer supplies should be conserved in the creeks and watercourses by the erection of weirs and dams; and that advantage should be taken of the winter floods and freshets to send streams down the effluent creeks of our northern rivers to be conserved where practicable in natural reservoirs for use in the dry season.

The fifth report suggested the constitution of trusts with authority to carry out these schemes, and outlined the powers which should be conferred by legislation on the trusts.

These reports led to the *Water Conservation Act of* 1881, and the *Irrigation Act of* 1883 which was the first Victorian legislation in which express provision was made for the construction of irrigation works.

This latter Act provided for irrigation trusts which were empowered to borrow money in the open market and levy rates, but not empowered to contract loans from the Government. These trusts were essentially private corporations not to any extent under Government control. The first to take advantage of this act was the Leaghur and Meering Trust—constituted 14th September, 1885—which drew its supplies from the Loddon River.

Up to this time £3,800,000 had been spent by the state on water supply—mostly on town supplies—but nothing whatever had been spent on irrigation.

In 1882, however, a number of waterworks trusts had been constituted and in that same year the Echuca and Waranga Shires had come together with an ambitious scheme of irrigation from the Goulburn River. The result was the constitution that same year of the Echuca and Waranga Irrigation District, with Mr. Stuart Murray, later Chief Engineer of Water Supply, as its engineer. Preliminary distribution works were at once put in hand, and as a temporary measure a pumping plant was installed on the river, to be displaced later by the Goulburn weir.

Meanwhile the works outlined by Gordon and Black were put in hand. They comprised chiefly timber and masonry weirs for the provision of domestic and stock supplies throughout the waterless Northern Plains.

On the Wimmera River a weir was constructed at Glenorchy to divert portion of the flow of that river into Dunmunkle Creek, and also via Swedes Creek into the Richardson River, where a weir with drop bar openings was constructed at Donald to conserve a supply for that town.

On the Avoca River, weirs were provided at Coonooer, Charlton, Boort Road and Quambatook. On the Loddon at Bridgewater, where a basalt reef ran right across the river, a masonry weir was constructed to divert water down the Bullock and Pryamid Creeks. Weirs were also built in the Loddon at Kinypanial, McRaveys, Leaghur and Kerang.

The only structure on the Campaspe was a weir near Echuca for the supply of that town.

On the Broken River, Casey's weir, a concrete structure partly on piles, replaced an old timber weir to divert water into the Broken Creek for Tungamah and Numurkah. Lower down the Broken River was the Pine Lodge weir, which was one of the few failures and was eventually abandoned for a site further up at Gowangardie where a new barrage, the Gowangardie weir, was erected.

Royal Commission on Water Supply.

The whole position, however, in regard to water supply was still far from satisfactory, and in 1884, a Royal Commission on Water Supply was appointed under the Chairmanship of the Hon. Alfred Deakin, who tackled the problem with characteristic zeal. Visiting America, he wrote a long and valuable report on irrigation there, its methods, structures and engineering generally. This was published as a progress report of the Commission. There were other progress reports dealing with irrigation in Egypt and Italy, and one making very important recommendations for the future carrying out of irrigation in the colony. The secretary to the Commission was Stuart Murray, a leading engineer of the day who later became Chief Engineer of the Water Supply Department.

In 1886, Mr. Deakin got through Parliament the first great *Irrigation Act* which marked a new era in the history of water supply legislation. This revolutionary act vested in the Crown the right to the use of all water in any stream lake or swamp; provided for the extinction of any riparian rights that might prevent the use of water for irrigation; authorized the construction of national works by the State; and enabled directly elected trusts to carry out their schemes with money advanced from the Public Treasury.

It is of interest to engineers to note that this act provided that water supply works should be carried out only by engineers who had received a Certificate of Competency from a Board appointed to examine and inquire into the qualifications of those desiring to obtain such certificates.

National Works—Goulburn-Waranga.

It was proposed that, as irrigation trusts were constituted, the more important works of regulation and storage should be undertaken by the State. The first work authorized — a weir for regulation and diversion — was on

the Goulburn River near Murchison. Plans for the structure were prepared by Mr. W. Henderson, and in 1887 a contract was let to Cornwall Darling and Company for its construction for a little over £90,000. The weir, 695 feet in length and 48 feet high, was constructed of mass concrete faced with granite. Along the crest were fitted 21 floodgates, each 20 feet wide by 10 feet high, and weighing seven tons, which in opening sink into recesses in the body of the structure. To operate these gates, three Leffel turbines built into the weir were provided.

The offtake channel on the western side—the Main Western channel—had bed width 113 feet, and was designed to carry 1,700 cusecs. The eastern offtake—going to Shepparton—was designed for 350 cusecs.

The main storage of the system, the Waranga basin, was surveyed before 1890, but, owing to the depression of the nineties, was not put in hand until 1902, just too late to be of use in the record drought of that year. This reservoir was formed by constructing an earthen embankment 4¼ miles long across the mouth of the Waranga swamp, thus forming a storage basin over an area of some 18 square miles. The original capacity was 197,000 acre feet, but in 1921, this was increased to 333,400 acre feet by raising the embankment to hold a further 10 feet of water, bringing the maximum depth to 31 feet and the area submerged to 23 square miles.

Loddon River Weir.

In 1889, a start was made with a regulating reservoir on the Loddon River near Laanecoorie to the design of the late Professor Kernot with Messrs Stuart Murray and Moline. This was a compound structure, comprising a mass concrete weir, 50 feet in height, provided with automatic tilting flood gates along its crest to raise the top water level of the reservoir by five feet, and an earthen dam extending from the concrete weir to the high ground on the left bank. The capacity of this reservoir was originally 14,500 acre-feet, but this has since been reduced by silting to 6,650 acre-feet.

Kow Swamp Works.

In the same year work was begun on the construction of an intake and regulator at the head of the Gunbower Creek, and on the improvement of that creek to permit the diversion of Murray River water to Kow swamp and thence to the Loddon River near Kerang.

Mildura Irrigation Settlement.

While in America, Deakin had met the Chaffey Brothers who had established successful irrigation settlements in California. At Deakin's invitation, George Chaffey, and later his brother W. B. Chaffey came out to Australia to investigate the possibilities of similar enterprises in Victoria.

The result was Mildura, a wonderful tribute to the vision of the Chaffey's who saw in that desolate remote corner of the then despised Mallee the possibilities of irrigation, and to their genius in transforming a wilderness into the thriving settlement we give acknowledgment to-day.

The Chaffey Brothers started work in 1886, and, although they themselves did not reap the reward they deserved, it was their enterprise that ushered in a new era in Victorian irrigation. The Mildura scheme, it might be remembered, was one of the earliest in the world involving high lift pumping on a large scale.

Irrigation Trusts.

Following the passage of the 1886 Act, there was at once great activity throughout the state in the investigation and submission of irrigation schemes, with applications for the constitution of irrigation trusts. The numerous "Blue Books," in which descriptions of these schemes have been published, provide evidence of the very widespread desire to take advantage of the generous provisions of the new legislation.

The Murray River.

All this time, the Murray River had been neglected owing to interstate difficulties, but, in 1902, as the result of a very influential and important conference at Corowa convened by the Murray River Main Canal League, an Interstate Royal Commission was appointed to report on the better utilization of the waters of that river. The report of that commission, a monumental work which outlined a comprehensive scheme for the development of the Murray and its tributaries for irrigation and navigation, still stands as a most valuable reference upon most aspects of irrigation in Australia. Many years had to pass however, before, in 1915, the first of the proposed works was put in hand.

Local Trusts Unsatisfactory.

By 1899 there were nearly 90 irrigation and waterworks trusts in operation in Victoria. But progress had been much faster on the engineering side than on that of the landowners, and when an attempt was made to collect the necessary revenue to meet interest on the cost of works, the whole system of local management broke down. In that year, 1899, a *Relief Act* was passed writing off three-quarters of the existing liability of the trusts.

The reasons for this failure of the schemes constructed and administered by locally elected trusts were, first and foremost, insufficient conservation of water: abundance of channels but not enough water to fill them when it was most needed; secondly, divided control of the sources of supply; thirdly, ignorance of irrigation; and fourthly, the inability of local management to face the financial position, and unwillingness to impose charges which would compel the proper utilization of the water by the irrigators.

Water Act, 1905.

In 1904, Stuart Murray, then Chief Engineer of Water Supply, at the direction of the Honourable George Swinburne, an engineer, who was Minister of Water Supply, undertook the colossal task of drafting completely new legislation to deal with the water supply problem. This became the famous 1905 *Water Act*. By it, all semblance of local control of rural water supply was removed, and, with the exception of the First Mildura Irrigation Trust, which continued to operate under a separate Act of its own, complete centralization was effected under a newly-constituted authority, the State Rivers and Water Supply Commission.

A feature of this Act was the declaration that the bed and banks of all streams should become and remain the property of the Crown, thus completing finally the nationalization of streams and other natural sources of water supply commenced by the *Irrigation Act of* 1886.

PART II. STATE RIVERS AND WATER SUPPLY COMMISSION.

Powers and Duties.

Under the 1905 *Water Act* and later amending acts, now consolidated in the *Water Act*, 1928, the powers and duties of the Commission include :—

i. the carrying out of surveys and gaugings to ascertain the nature and extend of available water resources ;
ii. the investigation, construction and control of works for the conservation and distribution of such supplies both for domestic and stock consumption and for irrigation ;
iii. the examination of swamp and marsh lands, and the investigation and carrying out of suitable reclamation works, both for flood protection and drainage ;
iv. the location and development of subterranean waters ;
v. the recording and publishing for general information of the results of such surveys, gaugings, borings and investigations ;
vi. the instruction and supervision of settlers in matters pertaining to irrigation ; and
vii. generally to promote the welfare of settlers in irrigation and water supply areas.

Water Rights and Charges.

In irrigation districts, a register is prepared of all lands and water-rights are allotted on a *pro rata* basis to the lands classified as irrigable. Water rights may vary from one acre-foot per acre for grass and fodder crops up to two and one half acre-feet per acre for the more intense culture of vines, citrus and other fruits.

Under Swinburne's 1905 *Water Act*, revenue was to be raised by a form of rating on unimproved land values, a system which would have returned to the state portion of the " unearned increment " resulting from its water supply expenditure.

Under a later amending act, however, the whole system of raising revenue was changed, and charges are now made on a quantitative basis. Water is now supplied by measure, at so much per acre foot, and, in order to ensure a regular income to meet interest and working costs, it is provided that the amount of the water-rights must be paid for each year whether used or not. The remainder of the water is sold on demand or under contract.

The act provides that water charges in each district shall be reviewed each year, and shall be based on the actual cost of supplying water to the district, including all working costs and maintenance together with interest and redemption on capital expenditure.

The charges made for irrigation supplies vary from 6s. to 22s. 6d. per acre-foot, or ¼d. to 1d. per 1,000 gallons, in the gravitation areas, up to 28s. per acre-foot, or 1¼d. per 1,000 gallons, where pumping is required.

In irrigation and in waterworks districts, charges for water supplies for domestic and stock consumption are based, not on the amount of water consumed, but on the valuation of the properties to which the supply is given—as in the metropolitan area—with a minimum charge in waterworks districts of so much per acre of holding. The *Water Act* provides that the rate may be made on either annual or unimproved valuation, except in the case of urban districts where it must be on the valuation used by the municipality for its rating purposes.

The minimum charges vary from 2d. per acre in districts supplied by sub-artesian bores up to 13d. per acre where water is pumped to a considerable height above the river and distributed to farms through open channel. The average over all districts is about sixpence per acre.

Water Storages.

Realizing that sound irrigation and water supply development must always be dependent upon the availability of water supplies when they are required, and that these can be assured from intermittently flowing streams only by the storage of winter flows for use in summer, the Commission from its inception has followed a most progressive policy of water conservation.

At the time of the great drought of 1902, which so clearly demonstrated the necessity for water conservation, the total capacity of storages in Victoria was 172,000 acre-feet. An active policy of construction has increased this to 1,909,000 acre-feet, or 530,000,000,000 gallons. Works in progress will, when completed, bring the total to 2,368,000 acre-feet or 644,000,000,000 gallons, equal to practically a whole year's flow of our northern rivers, an amount which would without replenishment supply the Melbourne metropolitan area for thirty years.

The major storage is the Hume reservoir on the Murray River just below its junction with the Mitta Mitta some ten miles upstream from Albury. The structure itself—a joint work with New South Wales—has a total length of a little more than a mile, of which two-thirds is an earthen dam with a concrete core wall, and the remaining length a mass concrete spillway.

The capacity of the storage to the present spillway crest 106 ft. above the river bed is 1,250,000 acre-feet, and provision has been made for raising the crest later and installing vertical lift steel gates, 20 feet in width by 15 feet deep, to raise the full supply level by 20 feet, thus increasing the storage to 2,000,000 acre feet.

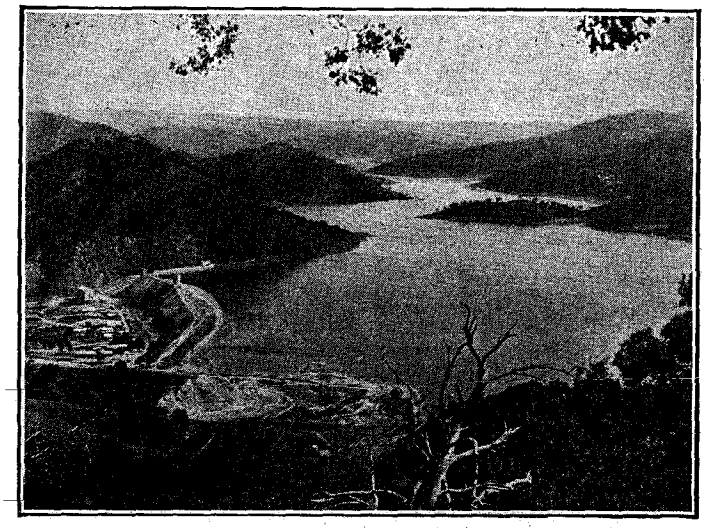
The spillway and gates are capable of discharging some 182,000 cusecs without raising the water in the storage to a dangerous level. Owing to the enormous flood retardation or pondage provided by the storage itself—which forms a lake 62 square miles in area, nearly four times the area of Sydney Harbour—such a discharge would not be reached unless the combined peak inflows from the Murray and Mitta Mitta Rivers exceeded half a million cusecs.

Irrigation Development.

Increases in water storage have been followed by a vast increase in irrigation. The total area of lands in Victoria commanded by irrigation channels—of which there are some 5,000 miles—is now 2 million acres as against 867,000 in 1906, and the area actually irrigated is over 500,000 acres as against 100,000 acres when the Commission was constituted.

Practically one-half the total area is supplied from the Goulburn system whose two storages—Eildon and Waranga reservoirs—hold between them nearly two-thirds of a million acre-feet. Water released from Eildon reservoir finds its way down the Goulburn River for 150 miles to the Goulburn weir already described, where portion of the flow is diverted into the Eastern Channel to irrigate Shepparton and Katandra, but the greater part into the Western Channel and on to Waranga reservoir whence it can be distributed throughout the Northern Plains between the Goulburn and Loddon Rivers. The main channel from Waranga, the Waranga western channel, now crosses the Loddon River and goes on to Birchip, a distance of 230 miles, to supplement the Wimmera-Mallee domestic and stock supply schemes.

The supply for another great gravitation system—the Torrumbarry system extending from Cohuna to Swan Hill —is drawn from the Murray River at Torrumbarry, 52



Eildon Reservoir, Goulburn River.

miles down stream from Echuca, where a weir raises the summer level of the river some sixteen feet and thus enables water to be diverted from the river throughout the year. A lock provides for the passage of river craft while the weir is in operation.

The weir itself—an original design evolved by the late J. S. Dethridge—comprises a series of movable steel trestles running on a concrete foundation and provided with wooden drop bars to keep the river up to diverting level. In times of flood, the bars are removed, and the trestles themselves drawn right out of the stream on to the river bank.

Other gravitation schemes of note are the Bacchus Marsh and Werribee schemes supplied from the Pykes Creek and Melton Reservoirs, and the Maffra-Sale scheme supplied from a storage of 104,500 acre-feet on the Macalister River at Glenmaggie.

There are, as well, a number of important irrigation schemes supplied by pumping from the Murray River. Of these, the most important are the Red Cliffs, Mildura and Merbein group, which form a compact area of 30,000 acres of vineyards, citrus groves and orchards. At Nyah also, some 3,000 acres are similarly supplied.

Irrigation development is still proceeding. The limit will not be the quantity of land that is suitable for irrigation —such land can be measured by millions of acres—but will be the total amount of water which can be conserved and distributed to these lands.

Domestic and Stock Supplies.

While irrigation works were proceeding in various parts of the State, work of no less importance was being carried forward in the extension of domestic and stock supply channels throughout the Wimmera and into the Mallee wheatgrowing areas. Since 1906 the area served by the Wimmera-Mallee scheme alone has been more than trebled, until now more than 11,000 square miles are supplied by its channels. To serve this area, which includes 43 townships and has a population of 120,000 persons, more than 6,600 miles of channels have been constructed by the Commission. The longest channel carries water a distance of 375 miles from the storages in the Grampians into the far north. The total capacity of the storages of the scheme, Lake Lonsdale, Wartook reservoir and others is now 200,000 acre-feet of which slightly less than one-half is required for watering the whole are in an average year.

The system is safeguarded against any possibility of shortage even in an exceptionally dry period by an extension of the Waranga-Mallee channel which enables supplies to be brought to it from the Goulburn system if required.

There are in addition to the Wimmera-Mallee gravitation system, several independent schemes where large areas totalling more than 1,000 square miles are served by channels filled by pumping from the Murray River.

In domestic and stock supply districts, farmers are required to provide excavated earthen storages on their farms of sufficient capacity to meet all their water requirements for twelve months, and the Commission's channels are run once only each year to fill them, generally during the winter months to reduce evaporation losses.

Outside the channel areas, some 1,000,000 acres of Mallee lands between Underbool and the South Australian boundary are supplied by sub-artesian bores. In this area the Commission has put down 110 five inch bores to depths of up to 900 feet, and has equipped them with large windmills and storage tanks from which the surrounding farmers draw their water requirements.

A Vast Undertaking.

The magnitude of the task of supplying rural Victoria with water may be appreciated when it is recognized that, by channels, bores and other methods, approximately one-fourth of the whole area of the state is now artificially supplied with drinking water for domestic and stock purposes, and that the state has, as a direct result of its expenditure on water supply, added to its productive area whole provinces which would otherwise have been practically non-productive.

This great work is being continued. After a period of consolidation rather than expansion, the Commission is about to commence the construction of a great river weir across the Murray at Yarrawonga, to add another province to the irrigated lands of northern Victoria—a province destined to become one of the most prosperous agricultural districts in Australia, and, with the adjoining irrigated areas in the Murray Valley, to take an important place among the irrigated areas of the world.

Summary.

Victoria—area	56,000,000 acres.
Rainfall	10 in. to 70 in.
Total expenditure country water supply to 30/6/1934	£25,000,000.
Expenditure evenly divided between irrigation works and domestic and stock supply works.	
Irrigation channels—length	5,200 miles.
Domestic and stock supply channels—length	8,200 miles.
Area of lands in Victoria artificially supplied with water for domestic and stock purposes by channels, tanks, and bores	15,500,000 acres.
This represents over one-quarter of the total area of the state—actually two-fifths of the agricultural lands.	
Area commanded by irrigation channels	1,984,000 acres.
Area under irrigated crops—1934	435,324 acres.
Storages—capacity	1,909,000 acre-feet
In course of construction	458,000 acre-feet
Districts administered by the Commission—	
Irrigated districts—Water supplied for cultivation	33 districts.
Domestic and stock districts—Water supplied to fill excavated tanks	33 districts.
Country town supplies for domestic use	98 towns.
Flood protection districts	5 districts.
Local waterworks trusts and local sewerage trusts—general control	138 trusts.