ROYAL COMMISSION ON WATER SUPPLY.

FIRST PROGRESS REPORT.

Irrigation in Western America,
SO FAR AS IT HAS RELATION TO THE CIRCUMSTANCES OF VICTORIA.

A MEMORANDUM FOR THE MEMBERS OF THE ROYAL COMMISSION ON WATER SUPPLY,

BY

THE HONORABLE A. DEAKIN, M.P.

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Price Sixpence.
We have also received from the Hon. Alfred Deakin, M.P., President of this Commission, a Memorandum of certain valuable information collected by him in the course of a visit to the United States of America, undertaken with the purpose of forwarding the objects of this Commission; a copy of which document we have now the honour to lay before Your Excellency.

We have the honour to be,
Your Excellency's most obedient servants,

ALFRED DEAKIN, President.
JAMES CAMPBELL, Vice-President
CHARLES YOUNG,
WALTER MADDEN,
JAMES SHACKELL,
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JAMES BALFOUR,

STUART MURRAY, Secretary,
Public Offices, Melbourne.

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A MEMORANDUM FOR THE MEMBERS OF THE ROYAL COMMISSION ON WATER SUPPLY.

Preliminary.

Since I had the honour of presiding over your opening meeting at the close of last year, I have visited America for the purpose of obtaining such a knowledge of the system of irrigation in that country as might throw light upon the possibilities of its application in Victoria, and thus assist you in the solution of the all-important problems of water supply into which your Commission was appointed to inquire. By a rapid tour through Colorado, California, Arizona, New and Old Mexico, Nevada, and Kansas, and, by the kind assistance of State officials, and of a large number of private persons, I was enabled to make a satisfactory inspection of the works and methods employed so far as they appear to have relation to the present circumstances of Victoria. The necessity for leaving Australia to obtain evidence of a practical order relating to agricultural production by means of an artificial water supply needs no remark. What experiment there has been among us in this direction is of so recent a date, of so limited an extent, and of so rudimentary a character that, to find a practical base for those recommendations which Parliament will expect to receive from the Commission, it seemed imperative that experiences of a much more varied nature should be laid before you.
Irrigation Area of the United States.

What Major Powell, chief of the Geographical and Geological Survey Department of the United States, aptly entitles its “arid region”—that is, the portion in which irrigation is essential to all agriculture—begins about midway in the great plains of the Central States, and extends across the Rocky Mountains to the coast range bordering upon the Pacific Ocean. It is an area of enormous extent, since it comprehends more than two-fifths of the whole territory of the Republic, excluding Alaska. Between this region and the “humid region” in which irrigation is unnecessary, stretches what he denominates the “sub-humid region,” in which irrigation, though not essential and not yet introduced, is, in his opinion, certain to be adopted in course of time to meet the fluctuations of its rainfall. In this last division is included one-tenth of the whole country. Consequently, according to this competent judge, irrigation, now a matter of the most vital interest to more than one-third of the United States, is likely to become in the future a mainstay of the agriculture of more than one-half of its vast domain. It is scarcely possible, therefore, to exaggerate the importance to the States of a study of its progress and promise. So far, however, it has not obtained that complete scientific investigation which the knowledge of such a fact would lead one to anticipate.* At present, what practical experience there is has been attained in the arid area of the south-west, 1,000,000 square miles in extent, of which not one-half has yet been surveyed. For the eastern boundary of this region Major Powell takes the isohyetal (or mean annual rainfall) line of 20 inches, which runs for the most part somewhat east of the one-hundredth meridian, and includes all the country west of this, with the exception of the strip of Northern California, Oregon, and Washington territory receiving the mists and rains of the Pacific Ocean. Out of this enormous tract, containing one-third as much land as the whole of Australasia, only some 3 or 4 per cent. is irrigable at any price. There is not water enough to supply more, and doubtless it could not be profitably supplied to nearly so much. The proportion actually irrigated so far can only be approximately estimated. The State engineer of Colorado reckons over 1,000,000 acres within his jurisdiction; the Congressional delegate for Utah adds 650,000 acres for that territory; the State engineer of California has supervision over an area of about the same extent; while in Arizona, New Mexico, and Kansas, though the totals are small in comparison, they are increasing steadily, and already works are constructed to supply a much greater acreage than is actually watered. Probably the water supply of this year will be able to cover 2,500,000 acres. This is more than are supplied in Italy, and far more than in France and Spain together. The area in Mexico is very great, but can only be guessed at. From what can be learned, it would, if added to that of the States, give as large an irrigated area to North America as to Europe.

Irrigation Era.

The extent of the area irrigated in the West is the more surprising since the practice, as compared with that of Europe, is a thing of yesterday. In Mexico, irrigation was practised before the Spanish conquest, and there are a few spots in its old provinces, now forming the south-western States of the Union, where, either at Indian villages or at the missions, plots can be seen which have been cultivated for a century by its means. In Utah, Americans began irrigating in a primitive way forty years ago, and their example was followed in that fashion, especially near the Mexican border, and under Mexican tutelage, for a score of years. But the real

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* I am indebted to the Hon. E. A. Carman, Acting Commissioner of Agriculture, and to his able assistant in the Irrigation Branch, Colonel Hinton, for a valuable and comprehensive description of the irrigable area of the United States, compiled from the yet unpublished records of the Agricultural Bureau at Washington, D.C., expressly for the benefit of this important information in the preparation of this Memorandum, but will be found in Appendix L.
The Visible Fruits of Irrigation.

Though in area American irrigation to-day may be compared with that of Europe, there is no comparison in age. As yet, indeed, there has been no comparison of the two systems, nor is there any work of which I am aware dealing with the irrigation of the West as a whole, or presenting its peculiar features. A few papers have been written upon particular instances, but these have little more than a local interest. If one seeks for an explanation of the reason why American irrigation is so famous, one finds that it is not owing in any degree to the completeness of the information published concerning it, but to the impression made upon every tourist through the arid area. A very vivid impression he cannot fail to receive, no matter how careless or indifferent he may be, for the glimpses obtained from a railway carriage window are a constant illustration of the wonder-working powers of an element, the need of which is so painfully evident for scores of miles along his route. The irrigated lands of America, though widely various, may be divided into two great classes. The rolling prairies of Kansas and sloping uplands of Colorado belong to one division. Poor and brown in ordinary seasons, their buffalos and bunch grasses are often green after favorable spring rains, and it seems but natural that, when a constant supply of water is secured, these treeless expanses should be gradually conquered by the march of settlement from thickly inhabited and closely cultivated districts. Not so with the sandy wastes stretching in a broad belt from the north to the south and south-west of the arid region. Here there is no prospect of any early invasion due to pressure of population or overflow from crowded towns. Here there is nothing to attract, and everything to repel. Here even the rich red mesa lands that lie under the shadow of the foot-hills are desolate at all times and in all seasons—so desolate that it seems impossible they should ever sustain a living thing. From them the limitless desert, bare and blinding in its glaring barrenness, stretches far away to the mirage towers that shift along a dull and undefined horizon. Much of the soil is so powdery even in winter that it follows in a lazy trail of cloud the horse of the solitary trader, or is sucked up in whirlwinds under the scorching summer sun. Elsewhere its gravelly and gritty surfaces, strown with splintered boulders, are seamed with gaping gulches and fissures of inappassable thirst. There is no grass, the only vegetation being a withered-looking brush resembling saltbush, the thirsty-looking cactus, a juiceless scrub like our ti-tree, or a thorny variety of stunted palm. Such is the Mapimi desert in Mexico, the Maricopa desert in Arizona, or the Mojave desert in California, and such, without water, they must remain. As it is, these wastes of sandy aridity and grey nutritious herbage, surrendered by nature to solitude, surround oases created and sustained by irrigation. In the distance the track of a canal, pleasantly breaking the dull level of the dried-up plain, is marked, sometimes for miles, by a line of green bushes following its sinuous course. By-and-by this line broadens as it into a great green plantation dotted with houses, divided into gardens, and decked with flowers. Its little fields, fringed with flourishing trees, are bright with fresh-springing pasture, upon which stock are grazing, or else crowded with dark orange groves and clustering vines. In the centre of it is a tiny township, busy with teams and traders where the train
stops for a moment or two. When it starts again the
houses and trees vanish as if by enchantment, and the
engine rushes on through the dreary desert once more.
It is thus that the eye bears testimony to the fruits of
irrigation in the south, and in the north, though in a
less striking way, the lesson is the same. The unpretens-
ious ditches that wind along the hill-sides or prairie
ridges are not notable themselves until it is perceived that,
where they are not, a scattered herd of rough cattle, a
small party of roving Indians, or a burly rancher, are
the only objects of interest, while, where they multiply,
are the buildings, the barns, and the business. A stretch
of open country broken by long ridges of canals, its
paddocks plotted off into little checks, with a barefooted
Chinaman or high-booted European, spade in hand, direct-
ing the water from one to the other, are common features
of the landscape, where one beholds industry and intel-
ligence transmuting barren surfaces into orchards and
fields of waving grain. Familiar, too, are the knots of
active men, the little camp of tents, and toiling teams,
that mark the progress of a new ditch into the wilder-
ness, where it is to create a settlement and maintain it
in the face of all seasons. The Indian pueblo, the Mexi-
can pueblo, the American township, all cluster about the
natural stream, or the artificial stream which makes it
serviceable. For in these parched regions its progress is
everywhere a triumphal march. It is here veritably the
water of life—life to the grass and flower, to the loaded
tree, to man and to the city of men whose homesteads
and harvests follow in its wake.

America as a Field of Inquiry.

But they are designed to meet the needs of a dense
imperfectly civilized population, whose habits and wants
differ from those of our race, and whose climate, country,
and water supply lead them to grow a class of products
chiefly foreign to our farmers. In the valley of the
Po, the practice of irrigation, by means of a culture of
immemorial experience, has probably reached greater per-
fection; but here too, as in the south of France and in
Spain, the conditions of existence are widely different
from those which obtain in the new worlds. In Italy and
parts of France there is a rainfall 75 per cent. greater
than ours, feeding numerous streams of considerable
magnitude, besides which there is a large population,
cheap in hire, frugal in habit, and trained from childhood
to the practice of employing water for agricultural pur-
poses. These countries have been long settled, much
divided, regularly cultivated, while their cultivators act
under a body of traditional customs, and local as well as
general laws, adapted to their peculiar circumstances.
They have the markets of the continent at their doors,
and steadily supply them. In many respects therefore,
the irrigating countries of Europe and Asia differ widely
from our own. The western States of America, on the
other hand, which can now claim to be ranked among
irrigating countries, present many likenesses to Victoria.
The climate of California resembles ours as much as that
of the South of France or Northern Italy, but with a
further resemblance that the rainfall of its warmer dis-
tricts is insufficient or irregular, so that, in more than
two-thirds of this State, artificial additions to it are ren-
dered necessary. It is like Victoria—a new country,
settled by the pick of the Anglo-Saxon race, attracted in
the first instance by gold discoveries, and remaining
after that excitement passed away to build up a new nation
under the freest institutions and most favorable conditions
of life. California is almost exactly the same age as our
colony, and in soil also the two countries are not unlike.
In both, water was first employed by miners, and in both
agriculture has been a later development. The price of
labour bears about the same relation in each to the price of commodities. Their products are similar, and in both the chief markets are found at a great distance. California, with the same population as Victoria, has twice our area, and as the State is oblong in shape and has its greatest length from north to south, it possesses within its borders a greater diversity of climate. The "coast" range of mountains divides it into a valley and a slope, the valley bounded by the Sierra Nevada on the east, and the slope on the west by the Pacific Ocean. Its agricultural lands lie mainly in the former, which is 450 miles long by 50 miles broad, and as level as the valleys of the Goulburn and the Murray. Its likeness to Victoria is most marked in its central portion, which includes its richest area. Except in climate and fruit products, the neighbouring Western States have many, though not so many, points of likeness to Victoria. In fine, the close resemblance of the peoples, their social and political conditions, and their natural surroundings, renders the parallel between Southern Australia and the Western States of America as complete as such parallels can well be. It is thither, therefore, that we should naturally look to learn with least difficulty the modes of successful irrigation.

State Inaction.

There are, however, not only likenesses but unlikelinesses, which present themselves in any contrast of the two countries; and among them one of the chief is the attitude of the State towards every form of enterprise, including the construction and management of railways, telegraphs, and water supply. In Victoria the water supply of cities and towns is generally in the hands of municipal bodies, who have carried out the works with money lent to them by the Central Government. In Western America the water supply is almost invariably provided by private companies. In one instance, that of Los Angeles, Cal., where this rule obtains, a water supply has been undertaken by the municipal body; but it is not employed for domestic purposes, being applied, curiously enough, to irrigation only. The outlay incurred is recouped by sale of the water to the farmers, a great number of whom have their plots within the city boundaries. The local governing body of Salt Lake, Utah, has also undertaken a similar work, though this is maintained out of the ordinary rates, instead of by sales of water. Local governing bodies, however, do not, as a rule, go so far as this even where, as in Los Angeles and Salt Lake, water for irrigation is as essential to the maintenance of towns as is water for drinking purposes. The utmost they do is to permit, as in Carson City, Nevada, a canal 6 feet wide to run along a main road unfenced, or, as in Phoenix, Arizona, to permit ditches 3 feet and 4 feet deep to cross their roads without requiring them to be fenced or bridged. Beyond this, the municipalities do nothing. State Governments never have done anything in the way of undertaking or assisting in the construction of irrigation works. They are not expected to undertake them, and there does not appear any likelihood of their ever having any proprietary connexion with them. The Central Government maintains, if possible, an attitude of even greater indifference. All the irrigation works of Western America, with the exceptions above named, have been constructed and maintained wholly and solely by private persons. Not only has the Government spent nothing upon them, but it has known nothing of them. They have been constructed outside the law, extra legally, if not illegally. Even now only two States and one territory have attempted to deal legislatively with any of the problems raised, and it is not claimed that in more than one of these has anything substantial been achieved. In Colorado the State engineer has issued one report, which includes a register of water rights. In California the State engineer has issued one report specially dealing with irrigation, but there is no register of water rights. In no other State or territory is there either report or register. These two reports are of great intrinsic merit, but have a further interest, inasmuch as they are the only official papers
published by any State bearing upon irrigation. The authors have done the best that could be done with the means afforded them, but none can be more keenly conscious than they are of the magnitude of the work still undone. Major Powell's work is of the highest value, but consists of only a few pages of a general nature, dealing with the conditions precedent to irrigation.

Difficulties of the Inquiry.

Only the fringe of the subject having been touched officially, the visitor who desires to study irrigation finds that the data upon which he must build his conclusions are not to be obtained readily garnered in a State office, but that they are virtually uncollected, and must be sought for in the fields of practical farmers. The officials of the Central Government and of the State Governments exhibit the most considerate courtesy, but can only regret that they have been so hampered by want of means and authority that they have not been able to carry on their work in this direction, so as to place the matter upon a scientific basis. This condition of things is doubtless largely due to the newness of the country, and will tend to disappear as these regions attain to the age, population, and organization of the Eastern States. All that could be done to urge the Legislature of California to action has been done by the State engineer, who, with his colleague in Colorado, has managed at last to partially educate public opinion as to the duty of the State in this relation. But their best endeavors at present can only point to the sources in which knowledge must be looked for. Obliged, as an investigator must be, to have resort at every turn to private persons, it is but right that he should acknowledge the frankness and kindness everywhere extended to the stranger. I cannot recall without surprise how courteously and cordially, even at the sacrifice of time and personal convenience, numbers of engineers, projectors, capitalists and their agents, vigneronists, farmers, stock-raisers, orchard-growers, millers, and business people, bestirred themselves to furnish the best information procurable, and assist my inspection of works. Even with all this aid, it has been difficult to secure such precise data ranging over certain periods of time as would allow of definite conclusions being drawn. The paper of questions to be put to irrigators prepared under my direction on the outward voyage (Appendix A) was only partially filled. A shorter and simpler series, circulated by the State engineer of California some time back, proved equally unfruitful, and from the same causes. The farmers of America compare favorably with those of any country in method, quickness, and caution, but they are not given to recording exact quantities of water, nor to the special conditions of its use, nor yet the results obtained with the exactness required for professional investigation. Many of them have been their own engineers or have employed engineers who either used no plans or have mislaid them. The many law suits as to the use of water now pending in California naturally render capitalists who have engaged in great irrigation enterprises within its boundaries somewhat chary of giving their private records for publication. Again, partly because of the neglect of the various States to collate facts and figures relating to irrigation, each district has grown up with its own theories, prejudices, and customs, differing often to a noteworthy degree from those of its neighbours.

Differences of Various States.

The circumstances of the several States also naturally lead to great differences in their irrigation works. The mountain torrents of Colorado require to be grappled with by large and powerful weirs before they can be raised so as to cover their high rolling uplands, while the shallow rivers of Southern California call for light structures only capable of elevating water a few feet so as to lead it across sandy plains. Farming in the bottom lands of Arizona has led to the use of wing-dams which
can direct the flood waters of spring along the ridges, and thence command the flats beneath, and a somewhat similar class serve for the low levels of Kansas, while its bench or mesa lands (the secondary flats or table lands running up to foot-hills) call for larger ditches and stronger works, drawing their supply from the turbid Arkansas. In Utah and New Mexico we touch upon primitive works supplying small plots of land with little driblets of the precious fluid, out of which, with care and economy, thriving settlements are built up. The parent source of this system, and indeed of American irrigation, is Old Mexico, where irrigation, from the simplicity of the Egyptian water-lifter to the masonry weir and solid stone aqueduct of centuries ago, spreads its sway over the whole of the territory classed in its temperate and tropical zones. If it is difficult to arrive at accurate information in the United States, in Mexico it is impossible. There is no trustworthy measurement of water, and but the loosest measure of products; a majority of those who till are too ignorant, and the minority who own the soil too indifferent to record their experience; the State does nothing to assist, and has no bureau to take cognizance of this most important factor of its chief source of wealth. What knowledge exists is in the shape of oral tradition; what works there are, are either of the rudest kind or else all knowledge of their cost is lost in the past. Everywhere in the States or in Mexico private enterprise is supreme, and one learns only from private persons. The general condition is scanty collections of facts, and often opposite conclusions drawn from them. This diversity of local opinions casts upon the investigator the serious responsibility of deciding between them, and thus renders his task the more arduous. It is by contrast, therefore, of varying bodies of evidence, and by the aid of much expert opinion freely tendered, that the conclusions here put forward with this qualification have been obtained. It has been essential not only to see for one’s self, but to travel far and see much in order to discover what was worth seeing.

Mexican Irrigation Law.

Remembering the immense extent of the arid area, and the magnitude of the irrigation already undertaken in it, one cannot but be surprised at the nature of the legislation under which it has been developed. Still the omissions and mistakes made in the States furnish some valuable material; in Mexico there is little bearing upon the Victorian situation. The Aztecs were expert in the art of irrigation when Cortez landed upon their shores, and the Spaniards who conquered them brought their “Law of Waters” into force in their possessions. Under the Montezumas, water was the property of the commune; under the Spaniards it became the property of the king. In both the public interest was thus permanently recognized. Private acquisition was permitted for domestic purposes, but not for irrigation or industrial uses, except upon an authority derived from the Crown or its delegates as representing the public interest. Property in water, however, can be acquired by uncontested possession for twenty years, and is superior to property on land, since its owner has the right to carry over any land which may lie between his source of supply and the farm to which he wishes to apply it, on payment of compensation and justification of the route. There are a great variety of enactments relating to water in the several provinces and municipal districts; but as the water available for private use has been almost all appropriated, there is now little ground for litigation as to new diversions. Public rights are jealously guarded; a landowner near the head of a stream may not deprive a landowner lower down of his share. Unless he can obtain an official authority, he can use no water that is not derived from springs upon his own property. The chief measures of water are the Surco, which is equivalent to a flow of 0.23 cubic feet per second; the Naranja, which is one-third of a Surco; and the Paja, which is equal to 0.00053 cubic feet per second. In the city of Mexico and other important municipalities the Paja is the unit of measurement nominally employed. Law suits relating to the use of water are not uncommon;
of any further rights. Under a further provision, the national value of irrigation was recognised as in Mexico by the granting of a general power to any person to obtain an easement for his canal over his neighbour's land upon payment of compensation. Twenty-six water districts were defined according to the natural areas of drainage and supply, and a water master for each was appointed, whose duty it is to decide disputes between appropriators, and supervise the general distribution from a particular stream. By these simple means a host of difficulties and complexities were escaped, permanence was given to existing works, and encouragement offered for the construction of new works. It is not surprising, therefore, that, in mileage of canals or acreage irrigated, Colorado more than doubles any other State, or that its works are the greatest and most permanent, and are most rapidly extending. The territory of Utah has shown its appreciation of such results by copying as closely as convenient the legislation of Colorado. Its powerful church government has proved an invaluable administrative, judicial, and organizing agency.

Irrigation Law in California.

In California more has been attempted, and much less achieved. In that State there is no constitutional or statutory provision that the waters shall be public property, but the common law of England has been incorporated in the Civil Code of the State "so far as it is not repugnant to or inconsistent with the constitution of the United States, or the constitution or laws of this State" (sec. 4468). As a consequence, the doctrine of the right of a riparian proprietor to receive from the riparian proprietor above, and his obligation to deliver to the riparian proprietor below, the water of the stream upon which his land abuts undiminished in quantity and unimpaired in quality, has been revived, and is now being contested in the Supreme Court of the United States. The case stated is but the precursor of a cloud of litigation. If this doctrine be maintained on
the appeal now pending, all diversion of water for irrigation purposes would be rendered illegal—a consummation which could only be regarded as a national disaster. One effort has been made to mitigate the threatened catastrophe, but it is of limited aim and questionable efficacy. To protect those who have already made appropriations, an Act was passed in the recent session of the State Legislature declaring that the use of water for irrigation purposes is a public use, and that its distribution and price may be regulated by the supervisors (shire councillors) of each county. This offers no opportunity whatever for future appropriations, and it is yet somewhat uncertain how far it will operate in favour of the present appropriators, as its interpretation is likely to remain in doubt until tested in the Courts. In the United States, Acts of the Legislature may be reviewed by the Supreme Court, which has the power conferred upon it by the constitution to declare whether an Act of the Legislature is inter vires or ultra vires. For instance, there is already upon the statute-book of California a very valuable Act for the encouragement of irrigation, providing for the establishment of districts, the raising of funds, and the construction of works. This Act has been declared by the Supreme Court to be contrary to the constitution of the State, inasmuch as it leaves the establishment of the proposed district in the hands of its residents, instead of providing for its declaration by some representative body recognised by the law; hence it has remained a dead letter. The very valuable “Reclamation Act” passed in the same State has escaped this danger, because it is brought into operation in each district by the local governing board of supervisors. It has been suggested that the “District Irrigation Act” had another vulnerable point, since it provided that the minority of landowners in any proposed district might be compelled to contribute towards the scheme adopted by the majority, in spite of them and against their wishes; but as a recent decision has validated a “Drainage Act,” rendering contributions compulsory, even from owners who have not consented to the creation of a drainage district under that Act, it is now considered that no danger need be apprehended on this score. It is probable, therefore, that the former Act will be revived by a future amendment empowering the declaration of irrigation districts by the supervisors, in which case, even though dissenting owners are compelled to contribute, it is anticipated that the Courts will not raise any constitutional objection. Meanwhile, the measure is without force or effect. Even if the “District Irrigation Act” were valid, the riparian owner might still stop the way, or, if he were appeased, the various claimants might be unable to come to a settlement among themselves. Consequently, the irrigation representatives in California have set themselves three things to accomplish: to obtain the abolition of riparian rights; the registration and measurement of all claims to water, with provision for the granting of further rights of diversion; and, lastly, the constitution of irrigation districts. A Bill to accomplish the last purpose understood to have the approval of the State engineer, Mr. Hall, who is certainly the most competent judge of such questions in the West, as it deals with exactly the same plan which has been accepted by our own Legislature, is given in Appendix B.

Consequences of Imperfect Legislation.

According to the last message of the Governor of California to its Legislature, “rights to use water under the Civil Code are undefined and unproven claims, the extent and dates of which are known only to their holders or claimants,” a state of affairs which necessarily involves all parties interested in doubt and loss. How serious the loss is, owing to this unsatisfactory condition of legislation, may be better judged when it is recollected that almost the whole of the 150,000 people who inhabit Southern California are directly or indirectly dependent upon irrigation for their support. The value of the property in irrigation lands and works threatened in this State is publicly stated at £40,000,000. The injurious
results of the uncertainty as to the position of appropriators are discovering themselves on every hand. The splendid fruits of irrigation upon desert lands have all sprung from schemes commenced before this issue was raised. From that hour all projects for new works or the enlargement of works in existence have been paralysed. Canals which have a capacity for supplying 40,000 acres, with but little addition, continue to supply only 20,000 acres, as they did when the doubt was first raised. Only under most exceptional circumstances or on the smallest scale are any new projects being carried out in California. Where, as at Ontario or Redlands, extensive expenditure is being incurred, it is because the question of riparian rights cannot be raised. The proprietors of existing canals are, many of them, involved in a web of litigation; the legal expenses on one canal alone, which is not a special subject of contention, having added £4,000 a year to its cost of maintenance. The urgency of the situation has been so far recognised that the chief work of last session was a series of unsuccessful attempts to find a remedy agreeable to both riparian owners and irrigators. A special session was proposed to compel a settlement, but it was apparently considered that the interested parties were not ripe for a compromise. Neither party desires the final triumph of the riparian principle, even the riparian owners only seeking to gain this in order to obtain more favorable terms for themselves in future legislation. If that principle were adopted, it would mean the abandonment of irrigation. The contention at present really is for the possession of water for purposes of irrigation. The solution sought is how to distribute the water among the landowners upon the banks and those at a distance. The settlement of this difficulty, whatever it may be, must be such as to lead to an extension of irrigation by providing for the utilization of all the waters of the State under conditions that will protect alike the public interest and the private appropriator. The crippled condition of irrigation enterprise still remains an impressive warning as to the necessity for providing against these complications in a new State before vested interests become too deeply involved. In every country in which the practice of irrigation is grafted upon agriculture for the first time, the same difficulties must be met or avoided. The proprietorship of streams, the rights of riparian owners and appropriators, the extent of State control of the distribution of water, and whether special encouragement of the use of water should be given by entrusting the irrigator, under certain conditions, with a right-of-way over private property, are questions which have all to be determined. Outside of the laws already noted, there is no legislation of value to us in Western America. Outside of Colorado and Utah, Government has done nothing even to secure to the appropriator of water the fruit of his labour, or enable him to take a position in the Courts. In fact, legislative interference is only desired by the people of the States to untie the knots which the Legislature has either tied or neglected to untie. The utmost political aspiration of the American irrigator is that the Government will leave him severely alone.

Victoria and Western America.

In comparing the laws of America with our own, it is only necessary to place them side by side, but, in order to judge of the facilities for following American precedents in irrigation work, a general analysis of the physical conditions of each country is essential. The climate, soil, rainfall, and water supply must be first noted; after which the nature of the works, the method of applying water, and the character of the products obtained need to be taken into account. A glance at the means adopted for carrying out the enterprises, and special mention of any significant collateral circumstances, will then enable conclusions to be arrived at as precise, perhaps, as such a complex collocation of facts will permit.
Denver, Colo., where a stream of 2,880,000 gallons per day is derived from 80 wells, which range from 300 feet to 900 feet deep. In sinking these, the "club churn" drills have been found cheaper and quicker than the diamond drill, sinking 45 feet in 12 hours, as against 15 feet with the diamond drill, or 90 feet in 24 hours, as against 35 feet. The cost of drilling averaged about 8s. per foot, while in easy ground the work has been done for less than half this price. The character of the strata passed through will be found in Appendix G, and also a description of the simple machine employed in boring in Appendix II. When artesian water is used, the wells are, where possible, put down upon the highest part of the farm from which the water can be most easily distributed; when the water is raised by means of a windmill from an ordinary well, which is usually upon low ground, it is delivered into a light wooden flume, which conveys it into a reservoir on some commanding spot. In the Leon district of Mexico may be seen small cultivation plots, with perhaps half-a-dozen wells to the acre, in which the water rises to within 4 feet or 5 feet of the surface, and is then dipped out by an Egyptian lifter, consisting of a rude bucket swung on a long pole, with a counterpoise, resting upon an upright, by means of which the water is laddied into little irrigating gutters. In California, and especially at Florin, water is raised from depths of 10 to 20 feet in a steady stream, by means of windmills, one of which, as a rule, can supply 2 to 3 acres of land with water; and as the machinery employed costs only about £25 complete, this is not grudged by fruit growers. Further south the water is raised from more than twice this depth by the same means. In most cases the water is bored for and struck, but does not rise to the surface, the windmill being employed to lift it the extra distance. If water were found without boring at 10 feet deep, irrigation for vines or lucerne would be considered superfluous. The utilization of such small quantities of water as can be obtained by these means attests the value set upon any supply, however minute. Though the streams of the West are considerable in number, they are small and far between in almost every district in which irrigation is necessary. There are most extensive areas without appreciable rainfall, without rivers, and without springs. The irrigable area is narrow and widely distributed, occurring, except in Colorado and Kansas, in comparatively small allotments. A general view of the water supply of Victoria, remembering that many of its sources are yet unexplored, does not forbid the forecast that we may some day be able to compare our irrigable area with the area irrigated in most sections of equal size in the west of America. There may be greater difficulties for us to overcome at the outset, owing to our less extensive field for small individual enterprises; but, on the other hand, we can perhaps acquire the necessary knowledge in this regard from California, so that our larger undertakings may not suffer in consequence. We have not the natural mountain storage of moisture, in the shape of snow, released by the heat of the sun in the season when it is most needed upon the plains, which is the prime source of American supply. We shall be obliged to depend in a greater degree upon artificial storage, and for this also our topographical conditions are not so promising. Our first outlay, therefore, is likely to be larger and our engineering more important. These are circumstances which may impose conditions upon our efforts, but need be no bar to success.

Population and Wages.

An epitomized view of the natural conditions of Western America does not lead one to discern in those of Victoria the absence of any factor essential to success in irrigation. A smaller water supply means, of course, a smaller area irrigated; but, setting aside the question of area, upon which there are not data enough to found a comparison, the circumstances of the Pacific States, whether as regards climate, soil, or quality of water supply, do not appear more favorable to irrigation than those of Victoria. It has been feared that our present population is too small to allow
of the establishment of schemes of any extent; but the experience of America supplies a practical contradiction. In 1870, when irrigation was making rapid headway in California, that State, with twice our area, had but half our population; to-day, with its fifteen hundred miles of main canals, it scarcely exceeds us. We have in Victoria more than twice the number of inhabitants of Utah and Colorado together, where there are 1,500,000 acres under irrigation. In the States it is found that irrigation attracts population, and there is no reason why it should not do so here. Again, it has been argued that the rate of wages paid in Victoria virtually prohibits the construction of irrigation works. Here, again, the experience of the West is invaluable. Chinamen and Mexicans are paid 4s. a day, but are only employed to a limited extent, and the wages of whites are as high as they are in Victoria; unskilled labour cannot be obtained under from 6s. to 8s. a day, while farm labourers receive £50 to £80 a year, and skilled labourers 10s. to 16s. per day. In remote districts the rates are still higher. Yet, even with these wages, irrigation has paid, and is paying. Both apprehensions, therefore, are readily disposed of by a knowledge of the American situation. The social conditions, equally with the natural conditions, are found on examination to put no insurmountable obstacle in the way of the development of irrigation in Victoria.

Irrigation Works.—How Constructed.

It is next desirable to consider the means by which water is diverted, and the methods of its application, so as to share any knowledge which Americans possess in these directions. To comprehend the nature of their works, it is desirable to bear in mind their history, for they have rarely been the result of one foreseen plan, but have, as a rule, been brought into their present condition piecemeal. It must be remembered that they are not State works, and that, in many cases, they were not constructed by companies or capitalists, but by the farmers themselves, either singly or banded together. On the faith, perhaps, of a good season, the settler had taken up land, and, after his crop was in, had seen himself in danger of losing it, or else, in sheer desperation, he had settled without expecting a rainfall, and determined to try the Mexican custom of flooding his fields. In either case his necessity has been the same. He must have water, or be ruined. If it did not fall from the clouds, he has asked himself why it should not prove as efficient if obtained from the nearest stream. With this pressure upon him, he has not waited to inquire into his legal rights, or seek for engineering skill, or hold public meetings. He has hitched his team, and, with plough and spade, run a rough ditch to the river bank. By cutting this through, and, if necessary, throwing up a slight wing-dam to turn the water in, he has been able to soak his fields, save his crop, and, probably, get half as much again as an ordinary yield. Stirred by this gain, and by the strong sense of successful self-reliance, he has made his work permanent. A neighbour has joined him in enlarging the ditch, and then shared in its benefits. Others have been encouraged to face the same task. Where several were interested, they have joined their forces, apportioned the work, and each carried out his share, or paid for its being carried out for him. By these means a great number of so-called works have been constructed, and, learning from them, the small capitalist and the large capitalist have followed suit, and have built canals to supply water for use upon their own lands, or upon lands which they wish to let or sell, or upon the lands of others to whom they intend to dispose of the water they have secured.

Defects of Works.

These works have been built often without engineers, almost always without plans, and their defects are patent. The weir, head-gate, or wing-dam, as the case may be, has been carried away several times, and has probably cost more to replace than a substantial structure might
have done. Then the easiest courses for the ditches have been chosen, so that, instead of running on high land, they have even followed old water-courses, and thus have commanded from the canal a much smaller area, and more imperfectly, than they should have done. There have sometimes been no surveys, and, as a consequence, curves have been too sharp and grades too steep, so that the ditches gradually destroy themselves, cutting out their own banks and filling in their beds. Or, perhaps, an opposite fault has been committed, and there has not been current enough to keep down the water weeds, which spring up in the channel and choke it. Then, again, the natural result of individual effort of this kind has been that several canals have been built where only one was necessary. For instance, there are five ditches supplying the Mussel Slough district, Cal., where one would carry all the water with far less loss in the carriage. There are thirty-two canals taken out of the Kern River, where eight would have been abundant; and at Fresno half-a-dozen where two would have sufficed. What loss this involves may be estimated from a calculation of the State engineer, who, after a careful examination of two of these canals, finds that their combined stream could have been carried in one channel, at a saving of 20 per cent. of the water conveyed. The engineering defects of such works are palpable, and are not disputed or disguised. At the same time it would be a mistake to condemn them out of hand. At least, they have served their purpose for a time; it may be wastefully, but the waste could not have been prevented. Crop after crop has been saved, the farmer has kept his land, has built his house, and cultivated his plot comfortably by their means. If he now possesses the knowledge how to irrigate and how to build ditches, and has the money in his pocket to enable him to use his knowledge, he owes it all to these first rude efforts of his, by which he put the water upon his fields cheaply and without delay. The indolence of the Mexican leads him to be content with works of this kind from generation to generation; and though his practised hand succeeds better in managing water than the ordinary American farm hand, the structures from which he draws his supply are, as a rule, wasteful and without stability. Near the border even the energetic Californian seems to have partially succumbed to the same influence, where we find Riverside, probably the most famous settlement in Southern California, with its 8,000 acres of splendid orchards, taking 2,500 inches of water from the river by means of a rough brush weir and an open ditch, and, owing to losses by the way, only receiving 800 inches of it for actual use. In the same way the town of Los Angeles, the centre of a settled district, with 40,000 inhabitants, handsome buildings, street cars, and the electric light, derives its domestic and irrigating supply from the same class of work and in the same open ditches. But for the most part the tendency throughout the States is to improve existing works. In California the condition of the law has led to a paralysis of enterprise in quarters where law suits are dreaded; but where there is no such fear, and in Colorado, Kansas, and Arizona, the progress is very marked.

Irrigation Finance.

Everywhere, however, engineering work is characterized by extreme simplicity and economy; it is rarely massive, and never ornamental. There is no attempt at finish, but only at efficiency. Waterworks in the West are like railways, often made to pay for their own construction. At first, just enough work is done to enable them to yield a return, and then additions are made from time to time, until at last they are brought into a condition of stability. Money is not allowed to lie idle in any investment, but is made to pay towards its own maintenance as early as possible. Interest is high, and is taken into account in even the smallest transaction. This leads to the adoption of another principle, which may be said to be universal. This is running a certain risk whenever it can be shown to be profitable. In places where it is cheaper to build
a new weir or wing-dam of brush and sand every year than to pay interest upon the sum required for a permanent structure, the temporary work is invariably resorted to. It is rare also that any work is built strongly enough to endure all contingencies. The practice is to put up a weir that will stand in ordinary seasons, foreseeing that it will be swept away by the first of the heavy floods which occur periodically every few years. There are many ingenious engineering devices for decreasing expenses, but this principle of risk to save interest governs all. American engineers know that these works are not permanent when they build them. As a rule, they have the professional dislike of building temporary works, and, not having to provide the funds, prefer structures that will prove a lasting credit to them; but shrewd capitalists have tested the principle in practice, and they find it pays to resort in many cases to these slighter works.

Head Works.

Among the illustrations of this combination of risk with very clever engineering there are none better than those to be found at Bakersfield, where Mr. James, as engineer for Messrs. Haggins and Carr, has had a large field for the display of his ability. A detailed description of the most typical of his designs will be found in the Engineer's report. Timber is cheap in America, and California is favored with the redwood, which is soft, easily worked, and yet durable; consequently, it is almost wholly employed by Mr. James upon his 250 miles of canal. His main gates cost from £40 to £60, while his head-gates, controlling a flow of 30 feet or 40 feet of water 2 feet or 4 feet deep, are erected for £600. A wooden weir in the Callaway Canal, costing only £2,600, is 700 feet long, can be put in place in a couple of hours, and is ingeniously arranged so that its superstructure is rapidly removable. Many of the contrivances employed on these ranches are well worthy of imitation wherever shallow streams are to be dealt with in a level country. The combination of weir and bridge in the same wooden structure is another feature of these works well worth the attention of local governing bodies; one of these, 360 feet long, 20 feet wide, raising the water 5 feet, and reckoned to have a life of at least 20 years, being built for less than £2,000. In the streams of Southern California, which are of no great depth as a rule, brushwork is generally used for weirs and dams, sometimes being loaded with sand-boxes or sand-bags, or protected with fascines, loaded down with cobble stones. Thus the San Joaquin and King's River Canal, Cal., has such a wing-dam, 350 feet long; as has the Larimer and Weld Canal, Colo., where the dam is 177 feet long and 5 ft. 8 in. high. Examples of this class of construction on a great scale, though not for irrigation, may be found in the Yuba and Bear Rivers, where two dams may be seen, one of them 8,900 feet long, and the other 5,875 feet long, ranging from 8 feet to 15 feet in height, and from 60 feet to 120 feet in width. Perhaps the largest irrigation head-work in this style is that of the Eureka Canal in Kansas, which is 1,500 feet long and 8 feet high, supported by a dyke a mile long on the south side of the river, and diverting 5 feet of water through a cut in the banks of the Arkansas, 16 feet deep, into a canal 28 feet broad at the bed and 80 miles in length. The dimensions of these works, together with the stability of such head-gates as that upon the 76 Canal, Fresno, Cal., which is also a bridge 100 feet long and 20 feet wide, and raises the water 5 feet, at a cost of £1,000, and the ingenuity of the head-gate of the Chowchilla Canal, resting upon a quicksand, as described in the Engineer's report, are evidence enough of the ability which is displayed in many works. In Northern California there are both dams and weirs, of great height and excellent simplicity of structure, erected for mining purposes, and now, in a few cases and on a small scale, utilized for irrigation as well as motive power. For the most substantial of all head-works, however, we must look to Colorado. There are some small stone weirs in the south, and some fine pieces of masonry work of great antiquity in Mexico; but
American Engineering.

The engineering features of irrigation in the States need not detain us further at this stage. The specialties are the economy, simplicity, and, where necessary, the durability of their structures. In selecting the best means for attaining these qualities, the engineers act according to instructions. In America, a private capitalist takes the advice of his professional man, but only acts upon it according to his own judgment, or to the extent of his interest. The engineer has no hearing as to whether the soil is suitable, whether the crops will pay, or whether the financial prospect is promising. His business is to plan the necessary works in the most economical manner, and carry them out within the estimate. Should the plan be too dear, or the work fail to stand the strain prepared for, he runs the risk of losing his position, or more often a part of his business, since the practice of professional men is chiefly as consulting engineers. The exception to this rule is where the engineer would not be qualified to claim such a title in Australia. He is then simply a manager or foreman of a ranche, who has acquired sufficient knowledge of practical work to be able to construct head-works and excavate canals, and does what is necessary to secure a water supply as part of the ordinary operations of farming. There are many of these in the West, besides a number who, having some acquaintance with the theoretical principles of surveying and dam or ditch building, practise as engineers as well as land agents or colony managers. The class of professional men trained as engineers, and acting only as engineers, is small. But whatever be the standing of the engineer, it is always under the pressure of the private employer that the economical structures in use in the States have been built. The capitalist has taken care that they should be cheap, and the engineer has taken care that they are effective; a mutual check having been exercised, which it is probably not possible to obtain except in private enterprises.

Implements.

The cost of labour and material for works in the irrigating States is generally the same as in Victoria; where, for instance, as in timber there is a cheaper and easier material, it is less strong and less durable than our harder and heavier woods, and so the account balances itself. The only marked saving is effected by the use of implements specially adapted to the kind of work to be done in connexion with irrigation. The implements themselves are various, and a considerable portion of the saving is made in the knowledge when to use one and when to replace it by another. To begin with the simplest kind of construction, that of field ditching; the farmer does this, as a rule, with his plough, with which he can easily run a ditch of a few inches capacity across his field. If he intends to widen it while keeping it shallow, he employs the ditch plough, which consists of a blade suspended behind the share so as to push the earth which it cuts to one side. In many soils this is found to be an invaluable implement. When the work is more roughly done, what is known as a V scraper is brought into play. This varies from a mere log of wood with a couple of old spade heads nailed in front, forming a sharp prow, which is its rudest form, to a triangle some 6 feet wide at its wooden base, from which proceeds two long iron blades forming the acute angle. Its use is always the same. It is drawn by horses, and steadied by the driver’s weight, so as to push the earth outwards from a simple plough furrow or series of furrows, and thus form a ditch. When this is over 6 feet in width, a “side wiper” is generally substituted, which is a long iron blade, lowered from a frame which rests upon four wheels, so that when drawn by a powerful team it slants the ploughed soil to one side. In light soils and for large ditches, an elaborate machine is used, which not only ploughs the earth, but takes it up and shoots it out upon the banks a distance of 10 or 12 feet to either side, at the rate of from 600 to 1,000 cubic yards per day. But the implement most in
needs. It would be advisable, perhaps, to submit the wrought-iron pipe to experimental testing in view of the large extension of mains already contemplated for our metropolitan system. If it could have been adopted in the recently accepted contract for the 30-inch and 18-inch cast-iron mains, a saving of £10,000 could have been made to the Treasury. The one question concerning the pipes is as to their durability, and on this head we have testimony that they are in as good condition to-day as when laid fifteen years ago. There does not appear to be any other reason for questioning their success in California, or doubting that similar results will be obtained here; and if this should be the case, the reduction in the cost of large pipes for extending town supplies throughout the colony will be both great and permanent. They may also become of use in mining, as in the West, where they were first introduced in connexion with deep sinking by means of hydraulic machinery.

American Enterprise.

In closing this curt reference to matters requiring professional criticism, it may be added that, in the construction of all American works, there is one factor which must be taken into account in every calculation. It is not only the design of an ingenious implement, or a clever piece of engineering, but the use to which they are put and the rapidity with which they are improved and adapted to new conditions that commands one's admiration. The most potent factor in the achievement of American successes is the unifying energy and self-reliance of the people, many of whom, unfettered by tradition, independent of professional men, and original in idea, have conquered difficulty after difficulty, and added device to device in a way which it would be almost impossible to equal under any stereotyped system or by means of any one organization, no matter how well qualified its agents or inexhaustible its purse.

Method of Irrigation.

Just this same spirit of self-confidence and readiness of resource are carried into the methods adopted to utilize the water after it has been brought to the farm. There is nothing complicated about the process, though there is a good deal of judgment and practical knowledge brought into play at every turn. In this part of the work the patient Mexican often surpasses the impatient American, who is too anxious to rush the water over his land. There is a certain skill in the management of the fluid agent which is only acquired by experience, though the main duties of an irrigationist are simple in the extreme. Equally simple is the system by which the water is conveyed to him. From the main canal, fed by its head-work on the river, runs the secondary channel, which traverses a particular slope. Both of these are the property of the water owners. From the latter the farmer makes his own chief channel, or "lateral," which leads his supply to the highest point or points of his land. From this, again, his "sub-laterals" or field ditches intersect his farm, according to its situation.

Irrigation by Flooding.

The earliest, easiest, simplest, and cheapest method of irrigation is by flooding. The water is then directed so as to cover the whole area under cultivation to a depth varying according to the crop and the quality of the soil. This plan is the most wasteful of water, but cannot be avoided in the cultivation of cereals. The only work it involves in the field is that necessary to permit an even flow of the water. With a regular slope, this work is sometimes trifling, but, as a rule, some preliminary outlay is required for levelling inequalities or else providing for the equal distribution of the stream from points of vantage. When the fall is slight, shallow ditches are run in Colorado from 50 feet to 100 feet apart in the direction of the fall; when the land is steeper, they are carried diagonally to the slope, or are made to wind around it, and from these,
Land and Water to be United.

Another matter arising out of American experiences which it is desirable to notice, is the relation between the ownership of land and that of water. Where a farmer has his own canal to his own land, no question arises. Where a number of farmers excavate a ditch, and parcel the water out between them, the only question is as to whether the water used by each can be applied where he pleases, or whether it must be applied to particular acres specified in the contract. If he can sell his water to another, or turn it upon new land, the business of the company becomes more complicated, and the value of the lands first irrigated is not so well maintained. If, however, as is often the case, the farmers have been unable to make the ditch without assistance, and have called in a capitalist to join them, he frequently arranges to take up a certain amount of unoccupied land, which can be served by the canal, and from the sale of which he looks to derive a considerable share of his profit. To prevent competition, therefore, he generally stipulates that the water-rights which the farmers receive in return for their investment of labour or capital shall attach to their particular acreage, and cannot be transferred to any other land. By this means he secures for himself the market for all irrigated land outside of these acreages. When he sells what land can be irrigated by his share of the water, his interest in the canal determines, and the works become the property of those who own the various ear-marked acreages which it is confined to supplying, unless by common consent the proprietors then decree otherwise. Capitalists often construct canals into unoccupied country as a speculation, and sell so much land with a right to so much water attached, until rights covering the whole flow of the canal are parted with, and the new owners of the land become joint proprietors of the work which feeds it. In this way land and water are bought and sold together, the area of the land being measured by the quantity of water; for, in the West, all value may be said to inhere in the water. Land is plentiful, and almost worthless. The owner of the water really owns the land, for it is useless without his supply. The quantity of available water, and not the area of a territory, defines its agricultural extent; consequently, where capitalists have built canals to lands which they do not own, and have secured the water, they have really acquired the land too. They have the farmers absolutely at their mercy, and enjoy a monopoly of the most arbitrary kind. A landowner who obtains a water-right can carry a stream to his own property at a distance through land as good as his, which never can be cultivated except with his consent, and which will fetch only one-tenth of what his irrigated land will fetch, though the two are only divided by a fence. A recognition of the danger of allowing water to be monopolized without regard to the land has led a commission appointed to inquire into Californian irrigation to declare that, "as a matter of public policy, it is desirable that the land and water be joined never to be cut asunder; that the farmers would enjoy in perpetuity the use of the water necessary for the irrigation of their respective kinds; that, when the land is sold, the right to water shall also be sold with it, and that neither shall be sold separately." Major Powell, in his careful draft of a land system adapted to the arid region, most emphatically recommends that "The right to use water should inhere in the land to be irrigated, and water-rights should go with land titles." In Colorado, the feeling has gone so far that a proposal has been made in the Legislature to compel all canal owners to supply any persons with water, which they are not themselves using, at fixed rates; but as this would simply mean transferring to landlords who had invested nothing in canals part of the profit to be made by those who had so invested, the proposal was not entertained. Indeed, where the companies, as at Denver, sell the water-right with the land, and then contract to maintain a water supply in perpetuity for a fixed sum per annum, the system is unobjectionable, providing that, as
in these cases, the water-right has been properly obtained. In Colorado and Utah, notwithstanding their peculiar situation, the water is given to the first applicant, though he has to purchase the land to use it upon, which, without the water, would be worthless. It would have been more economical and more simple to have sold the water and given the land. Be this as it may, it is essential that they should always go together. The practice of tying water-rights to the land has another argument beside that of avoiding monopoly, and this is that it tends to a more careful use of the water by its concentration upon a smaller area. Whether the farmers by a committee maintain the works and supervise the distribution, or whether this is done for them under contract by a canal company at fixed rates, is not a matter of so much moment as in the latter case they are likely to be built substantially at the outset. When built by a capitalist, whose only object is to get rid of his land, poor works are often constructed, he being indifferent as to their permanence, so long as they last until he has sold out. After this, the obligation of maintaining or reconstructing them will be thrown upon those who have purchased from him. In Utah, the despotic authority of the Church furnishes a basis for communal organization peculiar to that territory, and proved to be of the highest value in settling new country. The one lesson to be learned in this connexion is, that in any introduction of irrigation into Victoria it will be necessary to provide against the separate ownership of land and water, except where the water may belong to the State or is sold under its regulations. All applications for water will require to be very carefully considered, and the grant of water-rights even for fixed periods jealously guarded. Though water with us may not be the vital necessity that it is in most of the irrigated districts of America, it is at least the means by which land can be greatly increased in value, in production, and in its capacity of sustaining population, and is, therefore, a treasure which no State can afford to give carelessly away.

Irrigation Enterprises.

The irrigation enterprises now proceeding in America or these recently carried out upon the larger scale have usually a considerable capital behind them. The farmers who were able by construction or agreement to irrigate have taken advantage of their opportunities, and it is necessary for those who wish to accomplish irrigation now to go farther afield. This the new settler can rarely do, and consequently he must purchase his land and water from a company which will ask him anything from £1 to £40 an acre for land with a water-right, and charge from 25s. to 2s. per acre per annum for water. The lower price is that of the outlying prairie land of Kansas, suitable for grain, while the higher price is for the best mesa lands of California, suitable for fruit. The average price for good grain land under a ditch and near a railway cannot be reckoned under £3, and will probably be nearer £5, while good orchard land will average about £30 per acre. These prices appear high, but the limit of available water even in America will probably send them still higher. There is little irrigable State land now unoccupied near either a railway or a settlement. The new settler buys from the capitalist or the company, who in their turn bought either railway grants or else private estates, paying from 6s. to £2 per acre. Some took up large areas of what were termed in California desert lands, offered to the public at merely nominal sums, and by means of irrigation have made them very valuable. But, as a rule, the lands open to small settlers were bought by their present owners at second hand, and are re-offered with water-rights attached. Even under these circumstances they yield large profits to the speculator. Not seldom the large estate-owner retains all the land he can acquire, irrigating it for his own purposes, so that it may already be said of parts of California that wherever irrigation is possible it is undertaken. The great estate is irrigated that it may raise more stock; internecine and other grasses are planted, and the carrying capacity of the whole multiplied many times over; or else part of the
estate is leased to farmers who irrigate, and who pay the owner a proportion of the crop. If the land is to be parted with altogether, the universal practice is to adopt what is known as the "colony" system.

The Colony System.

At first, as at Greeley, "colonies" were established upon something of a communal basis beyond the joint ownership of waterworks, but this is now very rare. It is still frequently the case to find them organized upon a temperance basis, or by the union of those of the same nationality, as in the Scandinavian and German colonies. The joint interest in the sources of their irrigation supply remain, but all other kind of community has disappeared. Under the most favoured plan, a piece of irrigable land is marked out into small holdings; either the landowner or a company construct works to supply these with water, and the lots are then sold to any purchaser with water-rights attached. By liberal advertising and easy terms of sale, new centres of population and production are created in this way in a very short time, so that the barren plain, in the course of a few years, becomes dotted over with these oases until one joins another, and, at last, they enclose and support a thriving and well-built city such as Fresno is to-day. Altogether there are some fifty of these colonies in California, some of them planned upon a large scale, such as Riverside, and containing their township within themselves. It becomes the interest of the original owners to make the advantages which their lands offer widely known, and, consequently, they turn themselves into emigration agents of the most energetic kind. The Eastern States are deluged with pamphlets; even the old world is reached by means of the printing office and by correspondence through the relations of those already settled. The aim is to make the place attractive, and no expense is spared to ensure success. In one such enterprise at Ontario the proprietors have laid out nearly £100,000 upon 8,000 acres of land, bought at 28s. per acre; of this sum about £10,000 was spent upon head-works for the water supply, which is conducted in 26½ miles of cement pipes to the corner of each ten-acre allotment, and in 3½ miles of iron pipes to the township for domestic purposes, at a cost of over £10,000. More than £20,000 in land was given to establish an agricultural college now built in the centre of the settlement, nearly £4,000 spent in planting trees and making streets, and £700 in securing a railway station. There is a double avenue running through the colony seven miles long in a straight line and 200 feet wide, planted with eucalyptus trees, and intended to contain a cable tramway, and the masts from which will be suspended electric lights run by hydraulic power. Over £17,000 was spent in advertising this colony, and the result is confidently awaited. Many persons, weary of city life, are drawn from the New England States, while numbers are attracted from the old world by the inducements held out to them. The colony enterprise has many advantages for those who engage in it. To join in it does not imply so great a trial as that of facing the wilderness with no neighbour less than miles away. It permits of society, of the establishments of schools, churches, and libraries, and the enjoyment of comforts which cannot be secured in isolation. It furnishes in fine a framework for commercial organization and the beginnings of local government. It appeals too to a larger class than that usually drawn to agriculture. The physical labour required is not so severe, there is more scope for intelligence, and it offers remunerative employment for a small capital.

Small Holdings under Intense Culture.

This is due not to the colony organization but to the fact that by means of irrigation small holdings under intense culture are proved to be profitable. The land and water which will produce 25 to 35 bushels of wheat at 2s. 6d. per bushel will produce, under fruit trees, a crop worth twenty or thirty times as much. One-twentieth or one-thirtieth of the area under fruit instead of grain
will yield as great a return and a larger percentage of profit. It has been found in parts of Europe where the water is the property of one owner and the land of many others, that the tendency of irrigation is to establish a monopoly in land. This is the case whenever the water is not attached to the land, and owing to a defective code law suits are frequent. But where water is attached to land, and rights are indisputable, there is exactly the opposite tendency—to cut up the land into small farms. It needs both men and money to prepare and plant 20 acres of fruit trees at once. It is as much as a hardworking man can do to attend to 20 acres of oranges or 25 acres of vines himself, and then he needs light assistance in the picking season. It is calculated that he can, by frugality, maintain himself and family upon half as much. Hence in the colonies 40 acres is a large estate; it requires hired labour and yields a considerable revenue. Whether colony life yields large profits or not, the visible evidences are all of prosperity. The little holdings are neatly tilled, with an air of perfect security, owing to their being often unfenced or fenced only by a row of trees; the houses are neat, well finished, well furnished, and of some architectural pretension; the people are comfortably dressed and well nourished, and their cattle in capital condition. Many of them brought their savings with them, and they are apparently content with their investment. The poorest places in these colonies have a far greater air of comfort than grain farms of two or three hundred acres in extent. Whole colonies have been settled direct from Europe by a peasantry trained to the most frugal and industrious habits, and with these success is immediate. The much more extravagant American has a harder time of it, if he starts upon his ten acres with less than £500, as he must maintain himself by laboring for others the greater part of his first three or four years. Still there are numbers who enter upon their little plots without even the money to pay for them, or build a house, or buy their tools. Many of these are dependent upon advances from the land companies, and, though interest is charged, the general result is that in a few years the hardy colonist has his homestead clear, and a profit from it which, in a few years more, suffices to maintain him, and employ him always upon his own land. Ten-acre blocks are gaining in favour in some districts, and nowhere can one observe deserted colonies, or parts of a colony, which show signs of the total failure of effort. The chief secret of the success of small holdings is the practice of the principle so long preached in Victoria of variety of products. On a ten-acre farm there will be a plot of lucerne, maintaining a horse and a head or two of stock; an acre or so of vines, another acre or two of mixed fruit trees, with perhaps an acre of some special kind of orange or apricot, an acre of grain or root crops, and a great brood of chickens. From these sources a family largely supplies its own wants in the way of food, and by the sale of its products provides clothing and comforts, and still lays something by, or more probably invests it in permanent improvements. With irrigation there are no bad seasons; with such diverse products no fluctuation of prices is feared; and in the proximity of schools and settlement the settler himself has no sense of exile from civilization, and need not fear that his children being left to run wild will grow up unfit for any change of life. Another very important consideration is that the labour of women and children can be utilized to a very large degree in the picking, packing, drying, and canning of fruit, to the advantage of the producer and of the employé provided with a thoroughly healthy and often attractive means of earning a livelihood away from the crowded town.

What has been Accomplished upon Small Holdings.

The success of small settlement in Utah is evidence of what can be accomplished in the face of the greatest difficulties. The tide of immigration constantly pouring into Salt Lake City consists of families often entirely destitute, and who have, as a rule, to become indebted to
the Church for their start. They have nothing but small plots of bare land, barren by nature, and are obliged from the very start to yield tithes yearly of all they produce; to give their labour to make the ditch which brings them water, and pay back their debts to the Church with interest. Yet these peasants are enabled to make homes for themselves, which, though plain, are not uncomfortable, and to steadily improve their credit, though trading at the store established in the Church interest, which is not obliged to offer the lowest prices. What has been achieved under these unfavorable conditions, where a sterile sand waste has been raised in value from 6s. to £20 an acre, for agricultural purposes only, can be secured anywhere in America or out of it by industry and thrift, if the water can be cheaply placed upon the land, and climatic conditions are not prohibitive. With these lessons in the value of intense culture, it is not surprising that the most intelligent and most enterprising irrigators desert grain growing for either stock raising or fruit growing as quickly as possible, nor that the newspapers and authorities of weight are persistently bringing before the eyes of others the relatively unprofitable character of wheat growing, and urging them to attempt higher culture. For its increase means the increase of population and of natural wealth. Railway accountants in California calculate that an acre in vines gives as much freight as nine acres of grain. A 640-acre grain farm can be managed by a farmer with two grown-up sons, except in harvest time, and at all other seasons the broad, bare fields and rude homestead are not indicative of permanent improvements. On the Barton vineyard, at Fresno, which has 540 acres under vines, 30 men are employed all the year round, without pickers. The winery, which is to receive the 600,000 gallons upon which the proprietor calculates, is a great building, 330 feet long by 96 feet wide; besides which there is a distillery and office in addition to the usual farm buildings surrounding a handsome residence and garden. The capital invested is £60,000, and the amount spent annually upon the 330,000 vines nearly £5,000. Thus under intense culture the same area as the grain farm is made to produce a hundredfold. With 640 acres under grain a farmer's position is precarious without irrigation, and but poorly profitable with it. Under fruit or vines it is a great estate, and its owner a wealthy man. The Barton vines are used to produce wine, while on small holdings they are usually employed to make raisins. It is calculated that the value of the products of Riverside will, in the course of a few years, be £260,000 per annum, and though the oldest it is not the best managed colony in California. It is hard to see why similar results should not be obtained in Victoria. There must be spots on which it would be comparatively easy to establish a colony of 8,000 or 10,000 acres, supplied with water by means of gravitation, and with a soil suitable to vine or fruit culture; there must be many places in which the rich soils of the northern plains and their splendid climate could be utilized so as to rival the finest Californian yields; all that is needed is the capital and enterprise on the part of the purchaser of the site, and the small capital or persistent energy of the settlers upon 20-acre lots to illustrate the wealth of Victoria under a system of intense culture.

Victorian Water Supply equal to that of the Arid Region.

There are certain difficulties in the way of agriculture in California which do not exist in Victoria. Though free from the rabbit pest, a small ground-rat, called the gopher, is a constant source of loss and annoyance in many districts; in many more the ground squirrels are almost as destructive; and in others the soil or water or both are so alkaline as to require the most careful handling in order to make them produce at all. Nor is the water supply of Western America, as a whole, so superior to our own as has been assumed. The coast to the north of California enjoys a rainfall as great as that which visits the belt
along the central ranges of Victoria, and parts of the south of this State, and of the east of the arid region in Kansas and Colorado, are well supplied by snow-fed streams. These, however, are exceptional tracts, and outside of them there are conditions more unpromising than our own. The territory of Utah is almost as large as Victoria, and is chosen by Major Powell as typical in the extent of its irrigable area of the whole arid region. It has been carefully surveyed, especially with reference to its facilities in this respect, and the result given is that out of its 80,000 square miles, 2,262 square miles, or 2.8 per cent., have been declared capable of being artificially watered. This is said by Major Powell to be probably the average ratio of the irrigable lands of Western America to those which cannot be irrigated. Adopting the reports of Messrs. Gordon and Black and Mr. Culcheth upon the Goulburn and Tragowel schemes as a guide, it seems certain that Victoria will be able to show at least an equal percentage.

Negative Conclusions.

With this suggestive fact, which is after all the keystone of the position, it may be well to close these notes upon the American development of irrigation. Such brief and superficial comparisons as could be instituted between the States and the colony have been given from time to time as they occurred, and require little recapitulation here. The difficulties of the inquiry, its incompleteness, its dependence upon conflicting evidences, and its strictly limited character were stated at the outset, and may be here taken as stated again. If it had resulted in nothing but a series of refutations, it could not be considered by any means unfruitful. It may be as well, before indicating the positive conclusions arrived at, to recapitulate the negative results. A knowledge of the circumstances under which American irrigation has been crowned with success rebuts the presumption that there is anything in our soil or climate which forbids the profitable introduction of irrigation, or that the limited nature of our water supply renders the field of its application so minute as to be unworthy of attention, disposes of the theory that our population is too small and our wages are too high to admit of extensive operations, contradicts the assertion that expensive drainage works are essentials at the outset of any scheme, and that artificial fertilization must be at once resorted to in order to secure remunerative crops, exposes the fallacy that irrigation deteriorates the quality of the produce and rapidly exhausts the land, dismisses the suppositions that grain will not pay for flooding, that the cost of canals is necessarily enormous, that works must in every case be constructed so as to endure for all time, or that irrigated areas are invariably pestilent, and at the same time puts to flight the fears that the State alone can undertake irrigation on a great scale, that private enterprise is unequal to the task of dealing with it, and that only a poverty-stricken population can be maintained by its means. The first irrigators in California were met by just such warnings and just such predictions of inevitable failure as have been sometimes given currency to in Victoria. The settlers of Fresno, in referring to their early struggles, quote word for word the same despondent prophecies which have been current in this colony. They, however, have lived to see them falsified by their own inexhaustible energy, patience, and self-confidence, and, with similar qualities, so may we.

Summary.—American Competition in Fruit.

In conclusion, then, so far as the evidence goes, the writer can discover no irremovable obstacle to the achievement in Victoria by means of irrigation, and in proportion to its irrigable area, of all that has been achieved in the Western States of America. Our climate is equal to the most favoured of all their climates, and, as far as known, our soil is not inferior. A smaller water supply in proportion to territory may render the area to be irrigated in this
for fresh fruit is a good market; but that of the East, like the wheat market, is regulated by foreign competition. The great reliance of the Californian "colonist" is upon canned or dried fruit, for which he finds a large and growing home market, in which it would be impossible to compete with him, and a smaller market abroad, where it might be possible for Victorians also to obtain a footing, as such products could be sent almost as cheaply by ship from Melbourne as from San Francisco to European or Asiatic consumers. Here, however, the demand is not great as yet, or else the trade is not established. The total exports of canned and preserved fruit from the States amounted in value, for the year ending June, 1884, to £110,000, out of a total export of fruit valued at £350,000.

And in Grain.

As the United States is regarded as a formidable exporter of agricultural produce, it is interesting to notice that, even so late as 1883, she imported one-seventh of her barley consumption and £48,000,000 worth of food products, reckoning only at sea-board prices, from which it appears that her farmers have still a large home market to supply before they can turn all their attention abroad. In her export of wheat it is the opinion of many of the well informed that within the next ten years there will be a great decline. The area sown in wheat fell nearly half a million acres between 1880 and 1884. In Minnesota, where it can be grown at a profit for 2s. per bushel, the increase in wheat production was only 10 per cent. between 1875 and 1880, as against 70 per cent. for the preceding five years. The verdict of American experts is that grain can never be a profitable crop for export at anything like present prices, and that there are many kinds of agricultural products which will always pay much better. The certainty is that sooner or later these views will materially decrease this particular class of product.
Our Markets.

But whether or not the American fruit-grower will remain without a rival in foreign ports, our farmers need not look far to find a market for the best paying crops which can be raised by irrigation. In 1884 Victoria imported in value a balance over our exports of £2,000 in olive oil, £2,500 in nuts, £4,000 in almonds, £10,000 in dried and bottled fruits, £23,000 in raisins and jam, and £80,000 in fresh fruit, or a total of £121,500 worth of the products of intense culture, which could be all produced in a few years from a single irrigation colony of 10,000 acres. The Australian market is still larger, its imports of those products from abroad for 1884 making up a total value of £385,000, in supplying which demand Victorian irrigators should find a good field for a long time to come (see Appendix K). Prices may be regulated by imports; but with the rapid growth of the colonies our producers have at least an enlarging home market, which it will tax all their efforts to control in the next decade or two.

Irrigation Not a Costly Improvement.

Nor need the outlay upon irrigation be feared by the practical farmer. If, as is likely, he could obtain a water-right giving him 12 inches in two or three floodings, whenever needed, for 20s., or even 25s. per acre, and a rental of 5s. or 10s. per acre per annum, it would possibly pay him even to grow grain. But it will pay him much better to grow beef or mutton upon lucerne, and to enter gradually into fruit-raising. Even Mr. Gordon's estimate of £5 14s. per acre for the irrigation, which would render the farmer secure against bad harvests, is nothing to the £10, or even £20 an acre, which has been expended, either in labour or in wages, in clearing many parts of Gippsland. Private enterprise has accomplished this without hesitation. Often it has been achieved by men without resources, who have earned by their labour elsewhere enough to live upon, while they gradually prepared their own selections for cultivation. And clearing, after all, does not ensure the regular crop promised to careful irrigation. The energy of the men who have already planted homesteads in the most heavily timbered and inaccessible parts of the colony, if applied to the irrigation of country which needs no clearing, as upon the northern plains, would have won even greater rewards.

Irrigation Profits Sure.

Not that it should be assumed that irrigation is a sure means to affluence and ease. In America, it has made large profits for those who had large sums to invest in starting colonies or watering their own great estates. To the farmer already upon the land, it offers a means of doubling or trebling the value of his land, if he can unite with his fellows in launching a scheme for mutual supply, as by means of an irrigation area under the present Act; but to him, apart from this, and to the new settler, it simply offers the prospect of regular employment and a regular income, which, with frugality and industry, will enable him to rear his family and make a home for himself, the value of which should rise steadily as he permanently improves it under careful cultivation. Irrigation is in fact the best possible insurance for the agriculturist, since, in many years, it prevents disaster, and, in all years, should more than repay its cost. Besides the confidence it gives, which enables him to undertake extended operations in any season, there is the gain in fertilization, and the increase in yield, which a professor at the Agricultural College of Colorado puts down at more than a hundred per cent. above what could be expected in a region with a defective rainfall. Irrigation, employed with foresight and skill in the raising of a variety of products, relieves the life of the agriculturist, always attractive in so many aspects, of its
one danger, by removing the element of risk, which robs it in bad seasons of most of its charms. With proper provision for drainage on low-lying lands, the pursuit should be perfectly heathful to the individual, and, under wise direction, should multiply, not by fits and starts, but by slow and steady accretion, his wealth, and the wealth of the community. Irrigation means immigration, if cheap passages from Europe and wide advertisement in the mother country are employed. A settlement of even the million acres of irrigable land which lie in the northern watershed of Victoria, if undertaken under judicious legislative and administrative control, should be the means of establishing there a prosperous and an intelligent class of farming citizens nearly as large as the whole population of the colony at the present time.

The Policy of the State towards Irrigation.

Though there are lessons in American experience, already referred to, which have convinced the leading politicians of the States interested that certain legislative and administrative duties should be undertaken by the Government, there is nothing either in their policy nor in their experience which casts any direct light upon the problem whether the State should assume any other attitude towards the man who increases the natural production and his own wealth by irrigating than it assumes towards the man who accomplishes the same results by reclaiming or clearing his land. The conclusions as to State action which have been accepted among so self-reliant a people would be worthy of attention if it were only because of the national tendency to which, in a measure, they run counter. Though they have been alluded to before, they are of so much moment that they will bear repetition, more especially as, if now called upon to offer suggestions as to the duty of the State towards irrigation, I could find firm foothold in American precedent for just the recommendations which would be made by the irrigators of Colorado or California. Their verdict, based in the first five instances upon a practical trial in one or other of the irrigating States of the course advised is, that—

Recommendations based upon American Experience.

(1.) It is essential that the State should exercise the supreme control of ownership over all rivers, lakes, streams, and sources of water supply, except springs rising upon private lands.

(2.) That it should dispose of the water to those desiring to irrigate, on such terms and conditions and to such an extent as may be determined by professional or qualified officers of its own, its object being to encourage the greatest possible utilization of the water on the largest possible area.

(3.) To ensure this, it should establish a scale of water measurement, and insist upon its employment in all transactions relating to water.

(4.) The State should appoint local water-masters to supervise the distribution of water, settle disputes, and exercise such a jurisdiction under a central office as shall guarantee the preservation of water-courses and other sources of supply.

(5.) Power should be given to holders of water-rights to obtain easements over private lands on payment of compensation and proof that the route asked for by them has been selected for sufficient reasons.

(6.) The State should furnish the fullest information as to the natural capacities of its territory for irrigation. The United States has already recognised its obligation in this direction. In addition to the work done by the Bureau of
Agriculture, as summarized in Appendix L, the Central Government is having prepared, under Major Powell's direction, a most elaborate series of maps, based upon careful surveys, showing the irrigable areas, the area suitable for pasture, the area of growing forest, and the forest where burned; while the State engineer of California has commenced such a close examination of that State as, if completed, would give the most complete picture of its irrigation possibilities, works, and practices. A similar course is being pursued in Colorado. Victoria, which has done something in this way, might very properly do a great deal more.

(7.) In California it is also held that, to prevent all irrigation from necessarily falling into the hands of capitalists, or any scheme for the general benefit from being negatived by one or two refractory landowners, there should be a means of organizing irrigation areas and creating corporations for them, who should be capable, at the bidding of a majority of those interested, of doing all things necessary to the construction of works and distribution of water, by means of funds borrowed upon the common security. Here, again, the State officers would be employed in protecting the public interest and testing the plans of projectors. This has been provided for in Victoria.

It seems to me, however, that without departing from methods approved elsewhere, we might go farther and adopt some of the minor forms of State encouragement already in operation in Europe. Even in America, judging from what is sometimes done in other ways, there would be little opposition to proposals for holding out inducements to the study of irrigation, theoretically and practically, as best adapted to local conditions. Such means of encouragement are used in France, in which country may be found a precedent for the despatch of the writer to Western America, where, some two years ago, a similar visit, with exactly the same objects, was paid by an official representative of the French Government.

Further Recommendations.

To understand the Victorian position we must note what has been done and what remains to be done, if we are to be guided by American evidence. In a more or less definite way, Victorian legislation has already recognised the power of the State over all sources of water supply (Mining Statute 1865, section 36; Land Act 1869, sections 46, 55, 56; Water Conservation Act, No. 716, sections 38, 41, 42, 46, 48, 78), the duties of a State department as to surveys (No. 716, section 15; No. 778, section 5), with provision for the constitution of districts (Part I., No. 778), and the issue of water-rights. It remains to provide (1) an unit of measurement, and (2) require the measurement of all water used. Were (3) our newly founded agricultural colleges made use of to train up a young generation of irrigators, (4) conferences organized among practical irrigators, (5) bouses awarded for the most successful farming by irrigation, and (6) prizes offered for the most fruitful studies of the best methods of utilizing our water supply, the development of a scientific system of irrigation might be greatly advanced. Our experimental farms (7) might be made actively experimental in irrigation, and (8) steps taken to put within the reach of those interested a knowledge of the latest successes in economical engineering, or in the art of artificial watering obtained from America or elsewhere. There might even be found a suggestion in the visit of the State engineer of Colorado to California and Utah for the purpose of inquiring into the progress in irrigation in those States, of the advantages likely to accrue to us from (9) a visit of inquiry to the colony paid by some such irrigation expert as Mr. Ham Hall, State engineer of California, one of the highest authorities in the States, previously engaged in the construction and
management of irrigation works, and author of "The Problems of Irrigation," now appearing. This would unquestionably afford a very satisfactory means of settling some of the questions as to the extent and value of our water supply, and the nature of the works calculated to distribute it most economically.

Should the State construct Head-works.

Whether we should cast upon the State the responsibility of the construction of head-works for irrigation is a question upon which American experience gives no answer. That experience makes it plain that the State cannot afford to ignore the questions relating to irrigation. It must regulate the diversion and sale of water and generally supervise all sources of supply. For it is clear that, if the sole control of any sources were to be conferred without restriction upon private persons or incorporated companies, there would be a possibility of creating a most injurious monopoly. The one motive of the private person or company, in controlling the supply, would be to obtain the largest profits or dividends. And, if these were the only objects sought, the tiller of the land, being entirely at the mercy of the owner of the water, would either be compelled to yield to exorbitant demands or allow his land to go out of cultivation. This, however, is a different issue to that raised by the question whether the State should itself construct irrigation works. There is no precedent in this direction, and only one expression of opinion. This is from Mr. Ham Hall, C.E., who, on theoretical grounds, was at first in favour of State assistance, but, on further research, has seen reason to greatly modify his views. He now says that:—"The State could not with safety enter upon the construction of irrigation canals, or materially encourage the building of such works, upon any other basis than that of the entire burden of the cost being borne by the property benefited, for the following reasons, viz.:—With such encouragement, works of irrigation would inevitably be pushed beyond the capacity of the water supply to fill the demand, and beyond the ability of the people to use the diverted water profitably. Thus irrigation would fail of a fair measure of success from one or both of these causes, and the State would have to make good towards the payment of debts incurred what could not be derived from the projects in a legitimate manner." It is in other and older lands than the United States that those seeking to extend the responsibility of Governments must look for illustrations of its advantages. But whether the verdict as to the actual construction of works be given for State action or private enterprise, one thing is clear, and this is that the works ought to be constructed. If Victoria is to continue to progress in the settlement of her people upon the lands and the multiplication of her resources by the conquest of those areas hitherto regarded as worthless; if she is to utilize her abundant natural advantages, bring her productiveness to the highest point, and secure to the agricultural population of her arid districts a permanent prosperity, it must be by means of irrigation. No price, it may be said, is too high for such a promise of progress. No price is too high, unless, indeed, it implies the sapping of that spirit of independence and of that self-reliant energy and enterprise which have won her present position; for by these, and these alone, can she maintain it.

Additional Results of the Tour.

In addition to the descriptions of works and machinery specially relating to irrigation given in the Engineer's report, a heterogeneous mass of information upon the water supplies of the chief cities of the United States, such as Chicago, Buffalo, Cleveland, Philadelphia, and San Francisco, has been placed at the disposal of the Engineer of the Melbourne Water Supply; plans and specifications of improved dredging plants have been forwarded to the Public Works Department; and copies of official papers relating to Railways, Agriculture, Forestry, and Health, distributed to the various offices interested.