

IRRIGATION.

INTRODUCTION.

Scope of the census of irrigation.—The basic inquiries included in the census of irrigation, taken as a part of the Fourteenth Census, are the area of land under irrigation, the capital invested in irrigation enterprises, the character of irrigation enterprises, and the crops grown under irrigation. The law providing for the Thirteenth Census directed that inquiries be made regarding other phases of irrigation, notably, prices of land and water rights, amount of water used per acre, and physical condition of irrigation works, and these inquiries were continued in the Fourteenth Census, although they are of secondary importance.

Territory covered.—The census of irrigation is confined to the part of the United States in which irrigation is a recognized feature of agricultural practice. It covered the following states: Arizona, Arkansas, California, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. In the remainder of the United States irrigation is practiced to a limited extent in the growing of fruit and truck crops by scattered individuals, but most crops are grown without it, and irrigation is only incidental to accepted agricultural practice; consequently this part of the country was not covered by the irrigation census, although certain questions relating to irrigation were included in the farm schedule and the replies to these have been tabulated separately. In Arkansas and Louisiana irrigation is limited to rice growing.

In the reports of the Thirteenth Census the data relating to rice growing were presented separately from the data for the arid region because rice growing was confined principally to parts of Arkansas, Louisiana, and Texas, where other crops were not irrigated. Since 1910 rice growing has assumed large proportions in California, where the area devoted to rice is not segregated from other irrigated land; consequently, the data relating to rice growing is not reported separately in the Fourteenth Census.

Reports of the Fourteenth Census.—The reports of the Fourteenth Census relating to irrigation are as follows: A report for each of the states covered by this inquiry, a summary for the United States, based on the state reports, and this report, which consists of the state and United States reports, a general discussion of the results, and several special tabulations not included in the United States summary and the state

reports. In addition to these separate reports, a chapter on irrigation is included in the Abstract of the Fourteenth Census.

Previous reports.—Inquiries relating to irrigation have been included in the Eleventh, Twelfth, and Thirteenth Censuses, and a special census of irrigation was taken in 1902. Reports for all of these inquiries have been published and the results are used in this report for purposes of comparison. No statistics of irrigation prior to 1889 are available, but in this report all data are classified by the dates of beginning of the enterprises supplying water, making it possible to show the progress of irrigation development prior to 1889 with some degree of accuracy.

Date of the census.—The date of the Fourteenth Census was fixed as January 1, 1920, while that of the Thirteenth Census was April 15, 1910. In each case the statistics of farms and area irrigated and of crops grown under irrigation relate to the preceding calendar year, so that the change of date does not affect comparisons in any way, the period covered being exactly 10 years. In each case the statistics of acreage to which existing enterprises are capable of supplying water relate to the year in which the enumeration is made, and here also the period covered in making comparisons is exactly 10 years. In the Fourteenth Census the capital invested in irrigation enterprises is reported as of January 1, 1920, while in the Thirteenth Census it is reported as of July 1, 1910, and the period covered in comparisons is 9½ years.

Method of collecting information.—The plan adopted for making the canvass for irrigation provided that the regular census enumerators should obtain from the persons controlling irrigation enterprises schedules representing small enterprises watering from one to three farms at the same time that they made the canvass for population and agriculture; and that special agents should obtain schedules for the larger enterprises and any small ones missed by the enumerators, after the canvass by the enumerators was finished. This plan was followed, and proved quite satisfactory.

Accuracy of results.—In general, the principal causes of inaccuracies in census reports are incompleteness in the canvass, lack of exact knowledge of facts on the part of those supplying information, carelessness on the part of enumerators in recording the information furnished them, and the errors incident to the handling of so large a mass of statistics in the short time allowed for the work.

There is no way in which the completeness of the canvass can be determined with absolute certainty, since there are no exact records against which returns can be checked. Both supervisors and enumerators, and most of the special agents, were local people who should know of the existence of all enterprises; in the sections covered by the irrigation canvass almost all enumerators and all special agents were working on a per diem salary and consequently would not be tempted to omit enterprises difficult of access; the farm schedule contained inquiries as to irrigation enterprises from which water was obtained, and all irrigation schedules were checked against the farm schedules to see that schedules were received for all enterprises shown on the farm schedules. In view of all these facts, it is believed that the canvass for irrigation was approximately complete.

As an offset to errors due to omissions, there is the possibility of duplication. Some farms receive water from more than one enterprise, and there is the possibility that they will be included in the areas served by all the enterprises from which they receive water; some enterprises extend into more than one county or state, and they may be reported more than once; and again, some enterprises are known by more than one name and may be reported more than once. Great care was exercised to eliminate duplication, and such as occurs tends to compensate for any incompleteness in the canvass that may have occurred.

The degree of probability of error on account of lack of knowledge of the facts varies considerably with the different inquiries on the irrigation schedule and the different classes of enterprises.

The inquiries which serve for classifying the data, namely,—source of water supply, character of enterprise, and character of water rights—should be correctly answered since it is probable that the owners of practically all enterprises, large and small, have exact knowledge on these points.

With regard to many of the points covered by the description of irrigation works, there will be a lack of exact knowledge. This is particularly true of capacities of the smaller ditches, length of the smaller ditches, capacities of the smaller reservoirs, and the capacities of wells, pumps, and engines. Most of the owners of pumps and engines should know the capacities at which their pumps and engines were rated by their manufacturers, but, in many instances, these ratings vary widely from that attained in actual practice. Most wells have never been tested beyond the capacities of the pumps being used in them, and it is probable that in only a small percentage of cases have the volumes pumped been measured. Therefore, the reported capacities of pumped wells represent the owners' estimates of what has been pumped from them, based on the rated capacities of the pumps used, not the volume of water that can be pumped from them, as determined by tests or measurements.

The owners of the small individual and partnership irrigation enterprises are likely to have quite accurate knowledge of the areas irrigated in 1919, since they are also the users of the water. The officials of the organized enterprises are not so likely to know the exact areas irrigated, since their records show, generally, only the areas for which the water users are entitled to receive water or do receive water, and not what is done with the water delivered. Usually in the larger enterprises farmers obtain rights to water for their entire farms, while it is seldom that a farmer actually applies water to his whole farm. For these reasons there will be a tendency for the areas reported to exceed the areas actually irrigated.

The statements as to area to which enterprises were capable of supplying water in 1920 are estimates, based on the condition of the works and the expected water supply. Here, also, there is a tendency for the area reported to exceed that for which water is actually available.

The area included in enterprises represents the estimates of promoters and, no doubt, it is greater than the area to which the enterprises reporting will be able to supply water when they are completed.

The area of irrigated land available for settlement represents the estimates made by officials of enterprises of the area to be irrigated by their enterprises that is not included in farms already settled. There is some tendency toward overestimates in this item.

For capital invested in irrigation enterprises, the amounts reported for the individual and partnership enterprises are almost all estimates. The larger parts of the works of such enterprises were built by the owners or their predecessors without any records of expenditures of money or time, and the same is true of many of the cooperative enterprises. It is probable that the estimates for many of these enterprises are too small. The amounts reported for the larger enterprises are much more likely to be based on records and, therefore, to be much more accurate. The totals ought to be approximately correct, with a slight tendency to be too small.

For many enterprises the cost of operation and maintenance was not reported and no attempts to estimate this cost were made. It is probable, therefore, that the cost that is reported is based on records and is correct. In tables showing this item the areas represented are shown in order that the reader may form his own judgment as to the value of the averages given.

The same condition exists with reference to the data relating to the quantity of water used. No estimates have been made for enterprises for which this item was not reported, and the data representing estimates and those representing measurements are shown separately. In every case the area represented is given to serve as an index to the value of the averages.

Acreege to which enterprises were capable of supplying water relates to the season following the time of taking the census and, consequently, is based on estimates made by those controlling the enterprises.

Acreege included in enterprises represents the extent of the plans of those controlling enterprises.

Acreege of irrigated land reported as available for settlement relates to land within existing enterprises and not to land that is susceptible of reclamation and settlement by new enterprises or extensions of existing enterprises.

Character of enterprises.—As stated previously, the establishment of large irrigation enterprises is controlled to a large extent by Federal and state legislation. The Federal Government is engaged directly in the construction and operation of irrigation works, and the several states have enacted laws to aid and encourage the establishment of large enterprises. The areas reported as irrigated and in enterprises will indicate the degree of need for further public aid or encouragement in the establishment of new enterprises.

The Fourteenth Census Act provides for inquiries as to the "location and character" of irrigation enterprises. The Thirteenth Census Act called for the same information, and provided further for showing in the reports the land irrigated under state and Federal laws, and whether water was obtained from national, state, or private works. In the reports of the Thirteenth Census the state and Federal laws for direct construction or for aid and encouragement to organization and construction under which enterprises operated were made the basis of the classes of "character" into which all enterprises were divided, and the same classification has been continued in the reports of the Fourteenth Census. The classes of enterprises under which all data are classified are as follows:

United States Reclamation Service enterprises, which operate under the Federal law of June 17, 1902, providing for the construction of irrigation works with the receipts from the sale of public lands and with other funds provided by subsequent legislation. In addition to serving land within its own projects, the United States Reclamation Service supplies stored water to land within other enterprises.

United States Indian Service enterprises, which operate under various acts of Congress providing for the construction by that service of works for the irrigation of land in Indian reservations.

Carey Act enterprises, which operate under the Federal law of August 18, 1894, granting to each of the states in the arid region 1,000,000 acres of land on condition that the state provide for its irrigation, and under amendments to that law granting additional areas to Idaho and Wyoming. The conditions contained in this law necessitate state legislation before the law becomes operative, thus Carey Act enterprises operate under both Federal and state laws.

Irrigation districts, which are public corporations that operate under state laws providing for their organization and management, and empowering them to issue bonds and levy and collect taxes with the object of obtaining funds for the purchase or construction

and for the operation and maintenance of irrigation works. They are controlled by the owners of the lands forming the districts through boards of directors elected by the landowners. Irrigation districts are more often organized for the purchase of irrigation works built by other agencies than for the purpose of building new works. In this report all enterprises now operating as districts, except those organized to take over and operate works built by the United States Reclamation Service, are reported as districts. In the case of United States reclamation enterprises, they are not reported as districts because the Reclamation Service still controls the projects to a large extent, and the districts are organized principally for the purpose of collecting charges due for water.

Cooperative enterprises, which are controlled by the water users under some organized form of cooperation. The most common form of organization is the stock company, the stock of which is owned by the water users. Some states have special laws providing for the organization of such stock companies, and in those states in which they are organized under general incorporation laws there are laws regulating their actions to some extent. The state laws governing operations under the Carey Act provide that works built under these laws shall be turned over to stock companies composed of the water users when certain payments have been made, and many commercial enterprises are organized on the same plan. In the Southwest, where irrigation was practiced before this territory became a part of the United States, much of the land is watered by "community ditches," or "public acequias," which are organized and operated in accordance with old Mexican customs providing for the election of officials by the landowners and for forced labor on repairs and cleaning. These enterprises are classed as cooperative.

The United States Reclamation Act provides that when the payments required by that act are made for the major portion of the lands in any enterprise, the management and operation of the works shall pass to the water users "under such form of organization * * * as may be acceptable to the Secretary of the Interior." Originally the Secretary of the Interior favored the organization of stock companies for taking over reclamation projects, but more recently he has favored the organization of irrigation districts.

Many of the enterprises now reported as cooperative enterprises were originally in some other class and have become cooperative.

Commercial enterprises, which supply water for compensation to parties who may own no interest in the works. Such enterprises may be organized in any form, but their operations are subject to some degree of public control in most states. This was the earliest type of enterprise for the construction of large irrigation works. Such enterprises built irrigation works and sold rights entitling the purchasers to receive water from their works upon the payment of annual charges, but conveyed no interest in the works. Many of the states have enacted laws prohibiting the sale of such rights, and commercial enterprises organized since the passage of these laws usually sell stock representing part ownership in the works, to become effective upon the payment of specified portions of the purchase price. These enterprises eventually become cooperative. There are some commercial enterprises that sell no rights but supply water to the public for charges based, in some instances, on acreage served, and in other instances, on the quantity of water delivered. In most states rates charged by commercial enterprises are subject to public control.

Individual and partnership enterprises, which belong to individual farmers or to neighboring farmers, who control them without formal organization. State laws provide the procedure for compelling part owners in partnership ditches to contribute their share of the labor and expense of operation and maintenance.

Capital invested.—The capital invested in irrigation enterprises is that reported by the owners. For the larger works the capital invested is taken, in most

cases, from books of account and represents the actual investment. In the case of most of the private and partnership and many of the cooperative enterprises, however, the works were built by their owners without records of labor or money expended, and the capital reported represents the owners' estimates. The schedules used in 1910 called for "cost," while the schedules used in the present census call for "capital invested," but the instructions accompanying the schedules make these two terms equivalent. In both cases the investment includes cost of construction and of acquiring rights. The latter usually consists of filing fees only, but in some instances it includes the purchase price of rights. However, these cases are so rare that they are unimportant. The cost reported for 1900 is designated "cost of construction," but probably includes the cost of acquiring rights as in 1910. For the Thirteenth and Fourteenth Censuses the average cost per acre is based on the acreage which enterprises were capable of irrigating in the census year and the cost to the date of the census—January 1, 1920, for the Fourteenth Census, and July 1, 1910, for the Thirteenth Census. Capital invested in enterprises for which this is not reported is computed by multiplying the number of acres to which the enterprises not reporting capital were capable of supplying water in the census year by the average capital per acre for the other enterprises of the same class in the same county. When the acreage for which capital was reported in any county was not sufficient to justify its use as a base for an average, the average for some other county having similar conditions was used. However, the percentage of enterprises not reporting capital was very small.

Operation and maintenance.—Cost of operation and maintenance was not reported on all schedules, and averages are based on the acreages irrigated in 1919 by the enterprises for which cost is reported. No estimate of total cost of operation and maintenance for all irrigation enterprises has been made, but if such a total be desired, it is probable that a total obtained by applying the average cost per acre in each state to the total acreage irrigated in that state, and adding these state totals for a United States total would be approximately correct. In the case of enterprises operating pumping plants the cost of operation and maintenance includes cost of fuel and attendance. In all cases the acreages on which averages are based are given to serve as guides to the value of the averages.

Water rights.—A water right is a right to take and use water from some specified source and to continue such taking and using of water from year to year. Water rights are divided into two general classes, with reference to the source of supply: (1) Rights to take water from natural sources, and (2) rights to take water from artificial sources, such as irrigation canals, which receive water from natural sources. The nature and

extent of rights of the first class are governed by state laws, while those of the second class are governed by contracts, rules, and regulations of irrigation enterprises.

There are in effect in the states where irrigation is practiced two more or less conflicting systems of laws governing water rights: (1) The English common law doctrine that the right to use water from a stream or other body of water attaches to land abutting on the stream or other body of water, known as the riparian doctrine; and (2) the American doctrine that water may be taken from streams without reference to the location of the place of use, known as the doctrine of appropriation.

In all states where irrigation is practised rights by appropriation are recognized, and some of the states recognize riparian rights also. In the reports contained in this volume the irrigated land has been classified by the character of rights under which it receives water. The classes used are defined as follows. They are discussed more fully in the various reports.

Appropriation and use.—In most of the states irrigation began before the states assumed control over water, and those needing water took it and used it. Their rights to continue the use were recognized by the courts and later by legislation, and many rights have no other basis.

Notice filed and posted.—The first step in public control of the use of water was the enactment of laws requiring those wishing to acquire rights to water to post at the points where water was to be taken notices of their intentions, or to file such notices with county officials, or to both post and file notices. These were to serve as notice to those coming later of the existence of the prior rights represented by the notices. In many of the states laws required all parties who had appropriated water before the passage of the laws to file notices of their claims, with the object of making complete records of rights; and many rights, originally acquired by appropriation and use, passed into this class.

Adjudicated by court.—Rights acquired by appropriation and use, and those represented by notices filed and posted, while they are recognized by law, are not defined as to extent or priority, since, in the first class there is no record on these points, and in the second class the records may bear no relation to the facts. When rights come into conflict they are carried into the courts and are then defined or adjudicated, and pass from the other classes into this class. Most of the states have laws providing special procedure for water-right cases. These are discussed in the United States summary and the state reports.

Permit from state.—The evident disadvantages of having rights undefined until they come into conflict and are adjudicated by courts, and the advance in the completeness of public control have led in most states to the enactment of laws requiring parties wishing to acquire rights to apply to some state official or board for permits. These applications must set forth in detail what is intended, and in their approval the boards and officials fix conditions as to extent of rights and time within which works must be completed, etc. Rights are not complete until proof of compliance with the prescribed conditions has been submitted, and certificates are granted by the state, but they are defined as they are acquired rather than only after they come into conflict with other rights. Rights reported in this class are in the process of being acquired rather than vested.

Certificate or license from the state.—The states having laws requiring applications for permits provide for the issuing of certificates or licenses when works have been completed and water put to use in

accordance with the terms of the permits issued, and some of the states provide also for the issuing of certificates when older rights are adjudicated by courts or administrative boards. This class includes all rights represented by such certificates or licenses, and may include rights originally in any one of the other classes named.

Riparian rights.—Rights in this class are those based on the ownership of land abutting on the source from which water is taken, in the states which recognize such rights. The most common interpretation of riparian rights in the western states is that the owner of riparian land may make any reasonable use of the water that will not interfere with a like reasonable use by all other owners of land riparian to the same source. Under such an interpretation the right is not fixed as to extent or nature, but depends upon the number of other owners and their needs.

Underground.—In most states public control of the use of water has not extended to wells, and, consequently, these have been put in a class by themselves. This class includes all land watered from wells.

Source of water supply.—The classes of sources of water supply into which all data are divided are self-explanatory. In making this classification for the reports of the census of 1910 all acreage was credited to what seemed to be the principal source of supply, while in the reports for the census of 1920 the attempt is made to represent the facts more closely by presenting various mixed classes.

Date of beginning.—In the reports that follow, all data collected in the census of 1920 have been classified by the date of the beginning of the enterprises supplying water. The date of beginning of an irrigation enterprise is, in some cases, the date when construction began, and, in other cases, the date of filing a claim or of applying for a permit. If a filing or application for permit was made and work was begun and continued with reasonable diligence the date of filing is considered the date of beginning, otherwise the date of construction is taken as the date of beginning. This classification should indicate the extent to which the plans of promoters of irrigation enterprises are realized in various periods of time after their beginning, which is a very important factor in financing irrigation enterprises.

Drainage basins.—In all previous regular censuses of irrigation all data have been presented by states and counties, but for determining the extent to which

various stream systems have been utilized and the possibilities of further development, the drainage basin is the more logical unit of territory. In the reports that follow all data are presented by drainage basins as well as by states and counties. The results of a special census of irrigation taken in 1902 were reported in this form, and these are included in the reports of this census, for purposes of comparison. The drainage basin of a stream consists of all land drained by the stream and its tributaries.

Units of quantity and capacity.—Capacities of canals, reservoirs, wells, pumps, and engines, and quantities of water used are expressed in the units commonly used in engineering literature to express the same items. They are as follows:

Capacities of canals and volumes of flowing water are given in second-feet, a shorter equivalent for cubic feet per second.

Capacities of wells and pumps are given in gallons per minute. Four hundred and fifty gallons per minute equal 1 second-foot.

Capacities of reservoirs are given in acre-feet. An acre-foot is the quantity of water that will cover 1 acre to a depth of 1 foot. It equals 43,560 cubic feet.

Capacities of engines and motors are given in horsepower. One horsepower is the power required to lift 33,000 pounds through a vertical distance of 1 foot in 1 minute of time.

Farm value of crops.—At the census of 1920, whenever a unit value for a crop could be used, such as the value per bushel or ton, the farmer was asked to report the acreage and production of each crop, but not the value. To supplement the information obtained from the farmers, the Bureau of Crop Estimates of the United States Department of Agriculture secured by special schedule from its crop reporters average values for such crops. These special schedules were tabulated by the Bureau of the Census, and the resulting averages, approved by the Bureau of Crop Estimates as representing a fair average of the farm value per unit, were used in computing most of the crop values presented in the accompanying tables.

For some products it was not possible to find any satisfactory unit on which to base a computation of the total value. Values were therefore obtained on the 1920 census schedule for vegetables, other than potatoes and sweet potatoes, and for the farm garden.

GENERAL DISCUSSION OF RESULTS OF IRRIGATION.

ACREAGE IRRIGATED.

The total area reported as irrigated in the United States in 1919, exclusive of the small areas of truck and fruit that are watered in the humid region, is 19,191,716 acres, an increase of 4,758,431 acres, or 33 per cent over the area reported as irrigated in the same territory in 1909. The increase in the area irrigated during the preceding decade was 6,688,818 acres, indicating that the rate of expansion during the last decade was much less rapid than that of 1899 to 1909.

Climatic conditions in 1919 were such that some land that is irrigated in normal years was not watered in that year. In the northern part of the Great Plains, in Montana, Wyoming, North Dakota, and South Dakota, the precipitation was much below normal, and streams were so low that there was no water for much of the land ordinarily irrigated. In the southern part of the Great Plains, in Oklahoma, Texas, and New Mexico, the condition was just the opposite—the rainfall was so heavy that land ordinarily watered needed no irrigation, and was not

reported as irrigated in 1919. It is not possible to determine from the returns the extent of the area ordinarily watered which did not receive water in 1919 on account of too much or too little precipitation. A comparison of the areas irrigated in the plains section of Montana, taken as a whole, in 1919 and 1909, shows a decrease of more than 200,000 acres. County boundaries were changed so much that comparisons for smaller sections are not possible, but it is known that in some sections the area irrigated in 1919 was greater than that in 1909; consequently it seems probable that the area not watered in 1919 in eastern Montana exceeded 200,000 acres. No estimate of the area in Texas and New Mexico that is ordinarily watered, but not in 1919, is justified by the returns.

The period from 1899 to 1909 was marked by a great speculative boom in irrigation development by private agencies, and by the beginning of works under the United States Reclamation Act in 1902. At the end of the decade the boom had spent itself and the Reclamation Service had spent its accumulated funds and has been compelled to proceed less rapidly than before. Between 1909 and 1919 there was no such activity, but a more normal expansion.

Government limitations on the issuing of securities during the world war probably checked reclamation work to some extent, although this was offset by the demand for the growing of the largest possible areas of food crops and the high prices of farm products, which tended to bring into use the idle lands under works already built.

Geographic distribution.—The geographic distribution of the area irrigated and of the increased area of irrigated land is shown in Table 1.

TABLE 1.—GEOGRAPHIC DISTRIBUTION OF ACREAGE IRRIGATED IN 1919 AND 1909, AND OF THE INCREASE IN ACREAGE IRRIGATED, 1909 TO 1919.

STATE.	AREA IRRIGATED.				INCREASE. ¹	
	1919		1909		Acres.	Per cent of total. ²
	Acres.	Per cent of total.	Acres.	Per cent of total.		
Total.....	10,191,716	100.0	14,433,285	100.0	4,758,431	100.0
Arizona.....	467,565	2.4	320,051	2.2	147,514	3.0
Arkansas.....	143,946	0.8	27,753	0.2	116,193	2.4
California.....	4,219,040	21.9	2,064,104	18.5	1,554,936	31.7
Colorado.....	3,348,385	17.4	2,702,032	19.3	556,353	11.4
Idaho.....	2,488,806	13.0	1,430,848	9.9	1,057,958	21.6
Kansas.....	47,312	0.2	37,470	0.3	9,833	0.2
Louisiana.....	454,882	2.4	380,200	2.6	74,682	1.5
Montana.....	1,681,720	8.8	1,079,084	11.6	2,045	0.1
Nebraska.....	442,090	2.3	255,050	1.8	186,740	3.8
Nevada.....	561,447	2.9	701,833	4.9	-140,386	...
New Mexico.....	538,377	2.8	461,718	3.2	76,659	1.6
North Dakota.....	12,072	0.1	10,248	0.1	1,824	(³)
Oklahoma.....	2,969	(³)	4,388	(³)	-1,419	(³)
Oregon.....	986,162	5.1	686,120	4.8	300,033	6.1
South Dakota.....	100,682	0.5	63,248	0.4	37,434	0.8
Texas.....	580,120	3.1	451,130	3.1	134,990	2.8
Utah.....	1,371,051	7.1	999,410	6.9	372,241	7.6
Washington.....	529,899	2.8	334,378	2.3	195,521	4.0
Wyoming.....	1,207,982	6.3	1,133,302	7.9	74,680	-1.5

¹ A minus sign (-) denotes decrease.
² Based on the sum of the increases, 4,900,236, not on the net increase.
³ Less than one-tenth of 1 per cent.

California reports the largest area irrigated, while Colorado ranks second, Idaho third, and Montana fourth. These four states reported the largest areas in 1909 also, but in that year Colorado ranked first, California second, Montana third, and Idaho fourth.

In increase in acreage irrigated California leads, Idaho ranks second, Colorado third, and Utah fourth. In all of these states the increases are fairly well distributed. Montana shows very little increase, but there was a large increase in the western part of the state, which was offset by the decrease due to drought in the eastern part. Nevada shows a considerable decrease. This decrease occurred almost entirely in the Humboldt Valley. Most of the irrigation in this valley consists in forcing the water over river-bottom lands during the spring floods. In Nevada 1919 was one of the driest seasons on record, while the snows melted early, leaving a very limited supply of water for use during the crop-growing season. Oklahoma also shows a decrease, which, as previously stated, is due to abnormally heavy precipitation rather than to drought.

The results of the Fourteenth Census have been tabulated by drainage basins, as well as by states and counties. The only other census for which results have been presented in this way is a special census of irrigation taken in 1902. The distribution of the acreage irrigated in this way in 1919 and 1902 is shown in detail in the table beginning on page 48. The distribution by the principal drainage basins is shown in Table 2.

TABLE 2.—DISTRIBUTION OF ACREAGE IRRIGATED, BY DRAINAGE BASIN: 1919 AND 1902.

DRAINAGE BASIN.	AREA IRRIGATED (ACRES).			
	1919	1902	Increase. ¹	
			Amount.	Per cent.
Total.....	10,191,716	8,874,408	10,317,308	116.3
Missouri River and tributaries.....	4,147,278	2,533,237	1,614,041	63.7
Mississippi River and tributaries other than Missouri River.....	968,403	393,087	564,806	143.5
Gulf streams other than Mississippi River and Rio Grande.....	698,077	21,833	676,244	.....
Rio Grande and tributaries.....	1,203,803	496,587	707,276	160.5
Independent streams in Rio Grande drainage basin.....	13,992	8,355	10,037	127.3
Colorado River and tributaries.....	2,312,047	927,183	1,384,864	149.4
Whitewater Draw.....	5,871	384	5,487	.....
Great Basin.....	2,313,103	1,039,473	673,690	41.1
Columbia River and tributaries.....	3,873,245	1,297,437	2,575,898	198.5
Pacific Ocean streams other than Columbia and Colorado Rivers.....	3,570,687	1,556,232	2,014,455	120.4

¹ Per cent not shown when more than 1,000.

Missouri River shows the largest area, with Columbia River second, and other Pacific Ocean streams third. The largest increase since 1902 occurred in the Columbia River Basin, the principal part of this occurring in the Snake River Basin in Idaho.

Distribution by type of enterprise.—The distribution of the acreage irrigated in 1919 and 1909, and of

the increase in acreage irrigated, 1909 to 1919, is given in Table 3, showing the relative importance of the various agencies in supplying water for irrigation, and in the increase in the area supplied during the last decade.

TABLE 3.—DISTRIBUTION OF ACREAGE IRRIGATED IN 1919 AND 1909, AND OF INCREASE IN ACREAGE IRRIGATED 1909-1919, BY TYPE OF ENTERPRISE.

TYPE OF ENTERPRISE.	AREA IRRIGATED.				INCREASE.	
	1919		1909		Acres.	Per cent of total.
	Acres.	Per cent of total.	Acres.	Per cent of total.		
Total.....	19,191,716	100.0	14,433,285	100.0	4,758,431	100.0
Individual and partnership.....	6,848,807	35.7	6,594,014	45.7	254,193	5.3
Cooperative.....	6,581,400	34.3	4,043,539	28.2	1,937,861	40.7
Irrigation district.....	1,822,887	9.5	528,042	3.7	1,294,245	27.2
Carey Act.....	523,929	2.7	288,553	2.0	235,376	4.9
Commercial.....	1,822,001	9.5	1,809,379	12.5	12,622	0.3
U. S. Reclamation Service.....	1,254,669	6.5	395,646	2.7	858,923	18.1
U. S. Indian Service.....	284,551	1.5	172,912	1.2	111,639	2.3
State.....	5,620	(1)	(2)	.....	5,620	0.1
City.....	40,146	0.2	(2)	.....	40,146	0.8
Other.....	7,236	(1)	(2)	.....	7,236	0.2
Not reported.....	570	(1)	(2)	.....	570	(1)

¹ Less than one-tenth of 1 per cent.
² Not included in classification in 1910.

Individual and partnership enterprises occupy, as in 1909, the first place, in extent of area supplied with water. These enterprises represent principally the earlier, easier, and cheaper types of construction. However, this class is particularly well adapted to irrigation from wells, and it is probable that both the number of enterprises and the area of land irrigated will continue to increase. On the other hand, there is, in some sections, a tendency to consolidate small enterprises by the organization of stock companies or irrigation districts. This tendency is indicated by the relatively large increases in the areas irrigated by enterprises of these types.

Cooperative enterprises supply water to about the same area as individual and partnership enterprises, the area served by them being also more than one-third of the total area irrigated—the two combined serve just 70 per cent of the total. Enterprises of this class showed the largest increase in area irrigated from 1909 to 1919, having more than 40 per cent of the total increase. This type of enterprise is not utilized for the development of new lands but rather for taking over enterprises of other types, particularly Carey Act and commercial enterprises after works have been built and lands have been settled. The increase in the area served by cooperative enterprises represents, therefore, transfers to this type and more complete use of old enterprises rather than new ones.

Irrigation districts rank third in area irrigated, and second in the extent of increase in the area irrigated from 1909 to 1919. Like cooperative enter-

prises, districts are not well adapted to the development of new lands and, speaking generally, the increase in area reported under districts represents reorganizations rather than new enterprises. The figures given in the table do not show the full extent of this movement, since the districts organized within United States Reclamation enterprises are not reported, because the Reclamation Service still controls these enterprises to a large extent, the districts serving merely as collecting agencies for the Reclamation Service.

Commercial enterprises supplied water to about the same area in 1919 as did irrigation districts. The figures do not represent correctly the importance of this type of enterprise in reclaiming land, since enterprises of this type are constantly being reorganized into cooperative enterprises or districts, and a considerable part of the area reported by enterprises of these classes was, in fact, originally supplied with water by commercial enterprises, and probably a considerable part of the increase reported for cooperative enterprises and districts represents reorganized commercial enterprises.

The United States Reclamation Service ranks fifth among the types of enterprises, in the extent of the area irrigated in 1919, having 6.5 per cent of the total. This does not represent the full extent of the work of the Reclamation Service since it supplies stored water to lands receiving their principal supply from other sources. The area thus furnished with a partial supply of water in 1919 was slightly less than one million acres. On the other hand, some of the land reported by the Reclamation Service was supplied with water by enterprises of other types that have been incorporated into the reclamation enterprises. In extent of increase in area irrigated from 1909 to 1919 the Reclamation Service ranks third, with 18.1 per cent of the total. This increase represents a real extension in the area irrigated, and not transfers from other enterprises, as is the case with cooperative enterprises and irrigation districts.

Carey Act enterprises show the smallest areas irrigated in 1919 of any of the types of enterprise engaged primarily in supplying water for irrigation, and they show also only a small part of the total increase in area irrigated during the last decade. Here, again, the figures do not present the whole truth, since under state laws Carey Act enterprises pass to cooperative enterprises as soon as they become well developed. However, there has been an almost complete cessation of activity under this law since 1910, except for the settlement of lands under enterprises begun previously.

The United States Indian Service supplies water to land in Indian reservations only.

Distribution by source of water supply.—The character and extent of the water supply for irrigation in the United States is discussed on pages 43 to 45, and in more detail in the section of this report

giving the results for the various states, in which area irrigated and capital invested have been classified on this basis.

The areas irrigated in 1919 and 1909, the area enterprises were capable of irrigating in 1920, and the area included in enterprises in 1920, classified by the source from which water is received are given in Table 4, on page 46. In the table which follows, the distribution of the areas irrigated in 1919 and 1909, and of the increases from 1909 to 1919, is shown.

TABLE 4.—DISTRIBUTION OF AREA IRRIGATED 1919 AND 1909, AND OF INCREASE IN AREA IRRIGATED 1909 TO 1919, BY SOURCE OF WATER SUPPLY.

SOURCE.	1919		1909		INCREASE. ¹	
	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total. ²
Total.....	19,191,716	100.0	14,433,285	100.0	4,758,431	100.0
Streams, gravity.....	14,527,060	75.7	12,767,351	88.5	1,759,709	36.3
Streams, pumped.....	1,226,510	6.4	608,050	4.2	617,851	12.8
Streams, pumped and gravity	199,595	1.0	(³)		199,595	4.1
Wells, pumped.....	1,283,098	6.6	480,341	3.4	773,757	16.0
Wells, flowing.....	65,856	0.3	144,420	1.0	-78,564	.....
Wells, flowing and pumped..	35,685	0.2	(³)		35,685	0.7
Lakes, pumped.....	35,730	0.2	17,826	0.1	17,904	0.4
Lakes, gravity.....	100,046	0.5	59,031	0.4	41,015	0.8
Springs.....	198,068	1.0	196,186	1.4	1,822	(⁴)
Stored storm water.....	98,873	0.5	105,792	0.7	-6,919	.....
City water.....	930	(⁵)	(⁵)		930	(⁵)
Sewage.....	2,578	(⁵)	(⁵)		2,578	0.1
Streams, gravity, and pumped wells.....	344,713	1.8	(³)		344,713	7.1
Streams, gravity, and flowing wells.....	82,065	0.4	(³)		82,065	1.7
Other mixed.....	996,021	5.2	44,079	0.3	952,542	19.7
Other, and not reported.....	13,148	0.1	(⁵)		13,148	0.3

¹ A minus sign (-) denotes decrease.
² Based on sum of all increases, 4,843,914, not on the net increase.
³ Not included in classification in 1909.
⁴ Less than one-tenth of 1 per cent.

In studying Table 4 it should be kept in mind that the classes used in 1919 are not exactly the same as those used in 1909. In 1909 land was credited to what seemed to be the principal source of supply, while in 1919 various mixed classes are used. However, all of the mixed classes combined include less than 9 per cent of the total area irrigated in 1919, so that the comparisons are substantially correct, except, possibly, for "streams, gravity." But if all of the mixed classes into which "streams, gravity" enters, including "other mixed," were added to "streams, gravity," there would still be a considerable decrease in the percentage of the total area irrigated represented by this class.

As shown by the table, more than three-fourths of the area irrigated in 1919 was supplied by streams by gravity diversion; more than 83 per cent of the area received its total supply from streams, by either gravity or pumping, while much of the balance represented by the mixed classes, received part of its supply from this source.

Wells furnished the full supply to slightly more than 7 per cent of the total area, most of this being supplied by pumped wells.

Springs supplied 1 per cent of the total area, but none of the other single sources supplied so much as 1 per cent of the total.

Of the various mixed classes "streams, gravity, and pumped wells" shows the largest area. In many places water is pumped from wells to supplement the supply by gravity diversions from streams, the extent to which the wells are used in any season depending on the sufficiency of the supply from the streams, a conspicuous example of this being found in the San Joaquin Valley, California. Another condition in which wells are used to supplement a stream supply is found in the Salt River Valley, Arizona. Here the rise of the ground water has injured considerable land, and wells have been put in for the double purpose of lowering the ground water and furnishing an added supply of water for irrigation.

Of the simple classes "streams, gravity," shows the largest absolute increase from 1909 to 1919, "pumped wells" ranks next and "streams, pumped," ranks third. In per cent of increase "pumped wells" stands first, "pumped streams" second, and "pumped lakes" third. Each of these pumping classes shows an increase of more than 100 per cent in the area irrigated; while no other class shows so high a percentage.

"Flowing wells" shows a decrease of more than 50 per cent. This is due to the increased draft on the artesian supplies, which has caused many wells to cease to flow. In most cases such wells are pumped when they do not flow.

"Stored storm water" also shows a decrease. Storm-water reservoirs are found principally on the Great Plains, and the abnormal season in that section in 1919 is responsible for this decrease.

Notwithstanding the fact that "streams, gravity" shows a decrease in the percentage of the total area served and a comparatively small percentage of increase from 1909 to 1919, it shows the largest actual increase from 1909 to 1919 in area irrigated. Pumped wells rank second, and pumped streams third.

The most conspicuous fact brought out by this classification of the area irrigated is the rapid development of pumping during the last decade. As noted previously, each of the pumping classes included in the table shows an increase of more than 100 per cent in the area served, while the average for all classes is only 33 per cent, and the increase for "streams, gravity," the largest class, is only about 14 per cent. In addition to the above, there is the large area receiving a partial supply from pumped wells. In all of the older irrigated sections there are large opportunities for watering new lands and for supplementing the supply from streams, by pumping from wells. Irrigation has brought the ground water near the surface, so that the pumping lift is small. The supply is re-

plenished by the continued irrigation of surrounding lands, assuring a future supply. This source is particularly valuable where stored water is not available, since it makes possible the growing of long-season crops where this would not be possible if water were available only when the streams are in flood.

Distribution of area receiving water from different sources, by states.—The distribution by states of the areas receiving water from the principal sources is shown in Tables 5, 6, and 7. All of the sources that report more than 1 per cent of the total area irrigated are included in the tables.

TABLE 5.—DISTRIBUTION OF AREA RECEIVING ITS ENTIRE WATER SUPPLY FROM STREAMS IN 1919, BY STATES.

STATE.	Total (acres).	Gravity (acres).	Pumped (acres).	Gravity and pumped (acres).
Total.....	15,953,165	14,527,000	1,220,510	199,595
Arizona.....	106,453	189,782	6,671	.....
Arkansas.....	6,120	120	6,000	.....
California.....	2,920,396	2,504,445	295,673	60,278
Colorado.....	3,050,904	3,028,787	12,747	9,430
Idaho.....	2,384,010	2,274,959	107,181	1,870
Kansas.....	32,137	30,307	730	600
Louisiana.....	271,152	10,226	248,306	12,620
Montana.....	1,550,827	1,515,212	15,743	19,872
Nebraska.....	437,532	435,507	1,115	850
Nevada.....	470,179	406,812	2,647	720
New Mexico.....	434,368	432,478	1,800	.....
North Dakota.....	11,499	9,030	2,469	.....
Oklahoma.....	2,710	2,522	188	.....
Oregon.....	851,183	786,354	64,576	253
South Dakota.....	93,360	92,491	809	.....
Texas.....	495,870	73,982	421,538	350
Utah.....	1,116,130	1,105,691	10,389	50
Washington.....	471,145	352,199	26,244	92,702
Wyoming.....	1,157,121	1,155,596	1,525	.....

Of the area receiving its entire supply from streams, water diverted by gravity supplied more than 91 per cent, that pumped supplied nearly 8 per cent, while the area supplied in part by gravity and in part by pumping was slightly more than 1 per cent of the total. The only states in which the area supplied by pumping exceeded the area supplied by gravity were Arkansas, Louisiana, and Texas. These areas represent the rice-growing districts in the states named and the area irrigated from the Rio Grande near its mouth in Texas, where most of the water is pumped. These three states report considerably more than one-half of the total area served by water pumped from streams, while California reports nearly one-fourth. Idaho and Oregon are the only other states reporting large areas.

California reports nearly two-thirds of the area receiving its entire water supply from wells. The rice-growing states of Louisiana and Arkansas rank next, the two combined reporting slightly more than one-fifth of the area. New Mexico, Texas, and Arizona follow in the order named. Only one state, North Dakota, reports no land irrigated from wells,

but the areas supplied from this source in Idaho, Montana, Nebraska, Nevada, Oklahoma, South Dakota, and Wyoming are negligible.

TABLE 6.—DISTRIBUTION OF AREA RECEIVING ITS ENTIRE WATER SUPPLY FROM WELLS IN 1919, BY STATES.

STATE.	Total (acres).	Pumped (acres).	Flowing (acres).	Flowing and pumped (acres).
Total.....	1,364,639	1,263,098	65,856	35,685
Arizona.....	41,810	39,694	1,558	558
Arkansas.....	135,260	135,260	.....	.....
California.....	868,060	826,846	17,053	23,561
Colorado.....	14,390	10,114	4,191	85
Idaho.....	1,545	414	1,131	.....
Kansas.....	13,285	13,235	.....	50
Louisiana.....	155,675	154,304	196	1,075
Montana.....	351	139	212	.....
Nebraska.....	546	546	.....	.....
Nevada.....	1,171	295	811	65
New Mexico.....	52,295	15,700	30,030	6,566
North Dakota.....	.....	.....	.....	.....
Oklahoma.....	125	107	18	.....
Oregon.....	2,405	1,993	72	340
South Dakota.....	130	.....	130	.....
Texas.....	44,466	39,493	3,256	1,727
Utah.....	12,394	7,308	4,908	178
Washington.....	20,665	17,504	1,071	1,400
Wyoming.....	166	147	19	.....

Of the area receiving its total supply of water from wells, pumped wells supplied 92.6 per cent, flowing wells 4.8 per cent, and mixed 2.6 per cent.

Since pumped wells supply so large a percentage of the total area supplied from wells, the area supplied by pumped wells is distributed in approximately the same way as the total. A notable exception to this is in New Mexico, where the area irrigated from flowing wells is approximately double the area irrigated from pumped wells. Neither North Dakota nor South Dakota reports any land watered from pumped wells.

Arkansas, Kansas, Nebraska, and North Dakota report no land watered from flowing wells. New Mexico reports nearly one-half of the total area irrigated from flowing wells, and California slightly more than one-fourth of the total, while Utah, Texas, and Colorado report considerable areas.

California reports nearly two-thirds of the area receiving water from both flowing and pumped wells. Many wells in southern California that originally flowed are now pumped, while others flow at times and are pumped at times. Most of the area reported in this class lies in that section of the state. In the Pecos Valley, New Mexico, much the same condition exists. These two states report about 85 per cent of the total area in this class.

As stated elsewhere, pumping from wells represents a later and more expensive stage of development than diverting water from streams. In all states there is opportunity for much expansion in this field whenever the returns will justify the expense.

TABLE 7.—DISTRIBUTION OF AREA RECEIVING ITS WATER SUPPLY FROM MIXED SOURCES, IN 1919, BY STATES.

STATE.	Streams, gravity, and pumped wells (acres).	Streams, gravity, and flowing wells (acres).	Other mixed (acres).
Total.....	344,713	82,665	998,621
Arizona.....	217,799	525	7,690
Arkansas.....	250	.....	1,817
California.....	87,897	4,255	223,424
Colorado.....	16,258	67,880	165,825
Idaho.....	357	1,927	54,601
Kansas.....	1,540	.....	350
Louisiana.....	10,045	.....	7,835
Montana.....	155	6,068	89,070
Nebraska.....	115	.....	1,120
Nevada.....	4,957	82	45,178
New Mexico.....	1,341	685	29,787
North Dakota.....	.....	.....	65
Oklahoma.....	.....	.....	125
Oregon.....	105	200	111,137
South Dakota.....	500	20	3,864
Texas.....	454	45	24,170
Utah.....	125	537	173,495
Washington.....	2,415	441	19,027
Wyoming.....	400	.....	33,043

The area reported in Table 7 for "streams, gravity, and pumped wells" represents land that receives its principal supply from streams, but gets a supplemental supply from wells. More than 60 per cent of the total area is reported for Arizona, and most of this area lies in the Salt River project of the United States Reclamation Service. By far the larger part of the water supply is diverted from Salt River by gravity, but wells have been sunk in places within the irrigated areas where the ground water has come near the surface. Water is pumped from these wells into the ditches carrying water from the river, and supplements the supply from the river. About 70 per cent of the remaining area reported in this class lies in California, mostly in the San Joaquin Valley. Here individual farmers have put down their own wells to supplement the water of large ditches from which they receive their principal supply.

More than 80 per cent of the land receiving water from both streams and flowing wells is reported for Colorado. Most of this land is located in the San Luis Valley on the headwaters of the Rio Grande, where there are many flowing wells.

Montana reports the next largest area, and this land is located principally in Beaverhead County. The remainder of the land is scattered through the states.

"Other mixed" includes so many different combinations that an analysis of the returns is not justified.

AREA ENTERPRISES WERE CAPABLE OF IRRIGATING AND ACREAGE INCLUDED IN ENTERPRISES.

The area enterprises were capable of irrigating and the acreage in enterprises are classified in the same way that all other data are classified in the tables contained in this report. These areas have been tabulated in the Thirteenth and Fourteenth Censuses as an indication

of the degree to which irrigation works are utilized and of the need for the construction of new works. The geographic distribution of the area enterprises were capable of irrigating in 1920 and 1910 and the excess of these items over the acreages irrigated in 1919 and 1909 are shown in Table 8.

TABLE 8.—AREAS ENTERPRISES WERE CAPABLE OF IRRIGATING IN 1920 AND 1910, AND EXCESSES IN THESE AREAS OVER AREAS IRRIGATED IN 1919 AND 1909, BY STATES.

STATE.	1920		1910		INCREASE, ¹ 1910-1920.	
	Acres.	Excess over area irrigated in 1919 (acres).	Acres.	Excess over area irrigated in 1909 (acres).	Acres.	Excess over area irrigated (acres).
Total.....	26,020,477	6,828,761	20,285,403	5,852,118	5,735,074	976,643
Arizona.....	627,303	159,738	387,655	67,604	239,648	92,134
Arkansas.....	173,013	35,077	47,136	19,383	131,877	15,684
California.....	5,894,466	1,675,420	3,619,378	955,274	2,275,085	720,152
Colorado.....	3,855,348	506,963	3,990,166	1,198,134	-134,818	-691,171
Idaho.....	3,092,810	604,004	2,388,950	958,111	703,851	-354,107
Kansas.....	67,853	20,541	139,995	102,516	-72,142	-81,975
Louisiana.....	728,742	273,860	553,220	173,020	175,622	100,840
Montana.....	2,753,498	1,071,769	2,205,155	526,071	543,343	545,698
Nebraska.....	562,468	119,778	429,225	173,275	133,243	-53,497
Nevada.....	704,708	143,261	840,962	139,129	-136,254	4,132
New Mexico.....	696,119	157,742	644,070	183,252	51,140	-25,510
North Dakota.....	34,235	22,163	21,917	11,669	12,318	10,494
Oklahoma.....	9,672	6,703	6,397	2,069	3,275	4,694
Oregon.....	1,344,046	357,884	830,526	144,397	513,520	213,487
South Dakota.....	1,150,914	50,232	128,481	65,233	22,433	-15,001
Texas.....	1,150,542	504,422	690,961	239,861	459,551	324,561
Utah.....	1,700,550	328,899	1,250,240	280,836	450,304	78,063
Washington.....	637,151	107,252	470,514	136,136	166,037	-28,884
Wyoming.....	1,831,039	623,057	1,639,510	506,208	191,529	116,849

¹ A minus sign (-) denotes decrease.

As shown in the table, existing irrigation enterprises were capable of supplying in 1920 nearly 7,000,000 acres in addition to the area irrigated in 1919. In other words, the area irrigated can be increased about 36 per cent, and considerably more than it has been increased in the last 10 years, without the construction of any new works or the extension of existing works. The corresponding figure for 1910 is about 6,000,000 acres, showing that the margin between actual use and possible use had increased about 1,000,000 acres since 1910. In the discussion of acreage irrigated in 1919 attention has been called to the fact that much land ordinarily irrigated was not irrigated in 1919 because of drought in some sections and because of excessive rainfall in others. It seems probable that this area will about offset the increase in the area for which water is available but not used. Even in that case, the latter area is more than the increase in the area irrigated between 1909 and 1919.

The last column of the table shows in what states the water supply ready for use has increased more rapidly than has the area irrigated, and in what states use has extended more rapidly, Colorado, Idaho, Kansas, Nebraska, New Mexico, South Dakota, and Washington being in the latter class, while in all the other states use has lagged behind.

This excess area consists in part of land in existing farms that is not yet watered and in part of land that

is not yet settled but is available for settlement. The extent to which the area consists of each of these classes is not shown by the returns. However, the schedules called for the area available for settlement, and the total area reported as available by enterprises reporting this item was 2,257,981 acres. (See pp. 94 to 99.) This is about one-third of the total excess over the area irrigated. Some further light is thrown on this question by Table 9, in which the excess is distributed by type of enterprise.

TABLE 9.—AREAS ENTERPRISES WERE CAPABLE OF IRRIGATING IN 1920 AND 1910, AND EXCESSES IN THESE AREAS OVER AREAS IRRIGATED IN 1919 AND 1909, BY TYPE OF ENTERPRISE.

TYPE OF ENTERPRISE.	1920		1910		INCREASE, ¹ 1910-1920.	
	Acres.	Excess over area irrigated in 1910 (acres).	Acres.	Excess over area irrigated in 1909 (acres).	Acres.	Excess over area irrigated (acres).
Total.....	20,020,477	6,828,761	20,285,403	5,852,118	5,735,074	976,643
Individual and partnership.....	9,255,760	2,406,949	8,080,700	1,402,152	1,168,990	914,707
Cooperative.....	8,403,293	1,931,898	6,191,577	1,548,038	2,211,721	273,860
Irrigation district.....	2,531,425	708,533	809,451	271,800	1,730,974	436,729
Carey Act.....	804,293	280,369	1,089,677	801,124	-285,379	-520,755
Commercial.....	2,700,563	977,562	2,954,166	1,144,787	-154,603	-107,225
U. S. Reclamation Service.....	1,680,043	420,074	786,100	390,544	894,453	35,530
U. S. Indian Service.....	484,480	199,935	376,576	203,664	107,910	-3,720
State.....	7,379	1,769	(*)	(*)	7,379	1,769
City.....	44,458	4,312	(*)	(*)	44,458	4,312
Other.....	8,546	1,310	(*)	(*)	8,546	1,310
Not reported.....	625	55	(*)	(*)	625	55

¹ A minus sign (-) denotes decrease. ² Not included in classification in 1910.

Slightly more than one-third of the excess area is reported by individual and partnership enterprises, and this does not, generally, represent land available for settlement, but land on individual farms that was not watered in 1919 for one reason or another. The areas not watered in 1919 on account of drouth on the northern Great Plains and in Nevada, and those not watered in 1919 on account of excessive rainfall in the southern Great Plains fall largely in this class.

Slightly more than one-fourth of the excess area is reported by cooperative enterprises. This is more likely to represent land in farms that is not watered than land available for settlement, although more of it will fall in the latter class than is the case with individual and partnership enterprises.

Irrigation districts, Carey Act enterprises, commercial enterprises, and United States Reclamation enterprises, the classes of enterprises that are engaged in reclaiming new land, taken together reported slightly more than one-third of the total excess. Not all of this represents land not yet taken up, but a considerable part of it does. From this tabulation and that of land reported as available for settlement it appears that between one-third and one-half of the total excess of area represents land outside of existing farms, and available for settlement—between 2,250,000 and 3,500,000 acres.

A fact shown conspicuously by this table is the decrease in land not watered in Carey Act enterprises. This is due to an almost complete cessation in the undertaking of new enterprises and the transfer of some old enterprises to enterprises of other forms.

The data given above indicate that irrigation works, taken as a whole, were utilized to about 74 per cent of their available capacity. Table 10 shows the extent to which works belonging to the various classes of enterprises were utilized, as represented by the ratio between the areas they were capable of irrigating in 1920 and the areas irrigated in 1919.

TABLE 10.—PERCENTAGE WHICH AREA IRRIGATED IS OF AREA ENTERPRISES WERE CAPABLE OF IRRIGATING IN 1920.

TYPE OF ENTERPRISE.	Per cent.
Total.....	73.8
Individual and partnership.....	74.0
Cooperative.....	78.3
Irrigation district.....	72.0
Carey Act.....	65.1
Commercial.....	65.1
U. S. Reclamation Service.....	74.6
U. S. Indian Service.....	58.7

The areas included in enterprises in 1920 and 1910, with the excesses in these areas over the areas irrigated in 1919 and 1909 are given in Table 11.

TABLE 11.—AREAS INCLUDED IN ENTERPRISES IN 1920 AND 1910, AND THE EXCESSES IN THESE AREAS OVER THE AREAS IRRIGATED IN 1919 AND 1909, BY STATES.

STATE.	1920		1910		INCREASE, ¹ 1910-1920.	
	Acres.	Excess over area irrigated in 1919 (acres).	Acres.	Excess over area irrigated in 1909 (acres).	Acres.	Excess over area irrigated (acres).
Total.....	35,890,821	16,699,105	32,245,404	17,812,179	3,645,357	-1,113,074
Arizona.....	813,153	345,588	944,090	624,030	-130,937	-278,451
Arkansas.....	240,480	102,534	52,853	25,130	193,597	77,404
California.....	7,805,207	3,580,167	5,490,990	2,826,250	2,314,847	759,911
Colorado.....	5,220,588	1,872,203	5,917,457	3,125,425	-606,869	-1,253,222
Idaho.....	3,789,048	1,291,242	1,291,242	2,115,725	-230,475	-827,483
Kansas.....	102,502	55,250	101,300	123,321	-58,738	-68,571
Louisiana.....	851,211	396,329	681,065	201,765	269,246	194,564
Montana.....	4,320,148	2,047,410	3,515,602	1,836,518	813,548	810,901
Nebraska.....	766,768	324,078	680,133	424,183	86,635	-100,105
Nevada.....	1,382,036	801,589	1,232,142	530,306	149,894	271,280
New Mexico.....	99,870	423,502	1,102,207	640,579	-140,418	-217,077
North Dakota.....	57,476	45,404	35,173	27,925	19,308	17,479
Oklahoma.....	11,742	8,773	8,528	4,140	3,214	4,633
Oregon.....	1,925,957	939,825	2,527,208	1,841,079	-601,221	-901,254
South Dakota.....	138,382	87,700	201,625	138,377	-13,243	-50,677
Texas.....	1,687,447	1,101,327	1,253,173	802,043	434,274	299,284
Utah.....	2,359,244	658,693	1,947,625	948,215	411,619	-289,522
Washington.....	839,795	300,896	817,032	432,654	19,763	-175,758
Wyoming.....	2,564,668	1,356,038	2,224,298	1,090,996	340,370	265,690

¹ A minus sign (-) denotes decrease.

The excess of the area in enterprises over the area irrigated in 1919 was 16,699,105 acres, which is a little less than one-half of the area included in enterprises; that is, all enterprises taken together are watering a little more than one-half of the land included in their plans. The excess area is 87 per cent as great as the area irrigated in 1919, hence the completion and full utilization of all existing enterprises would permit of almost doubling the area now irrigated.

The area included in enterprises increased between 1910 and 1920 less than did the area irrigated or the

area enterprises were capable of irrigating, indicating that it was a period of building up under existing enterprises rather than of undertaking new enterprises. This is shown conspicuously by the last column of Table 11, which shows a decrease from 1910 to 1920 in the excess of area in enterprises over area irrigated for the irrigated region as a whole and for many of the states.

The distribution of the area in enterprises and the excesses over the areas irrigated, by type of enterprise, are shown in Table 12.

TABLE 12.—AREA INCLUDED IN ENTERPRISES IN 1920 AND 1910, AND THE EXCESSES IN THESE AREAS OVER AREAS IRRIGATED IN 1919 AND 1909, BY TYPE OF ENTERPRISE.

TYPE OF ENTERPRISE.	1920		1910		INCREASE, 1910-1920.	
	Acres.	Excess over area irrigated in 1919 (acres).	Acres.	Excess over area irrigated in 1909 (acres).	Acres.	Excess over area irrigated (acres).
Total.....	35,800,821	16,609,105	32,245,464	17,812,170	3,555,357	1,113,074
Individual and partnership.....	13,008,415	6,150,008	10,021,067	4,020,453	2,987,348	2,133,155
Cooperative.....	10,628,543	4,047,143	8,830,197	4,180,658	1,798,346	130,615
Irrigation district.....	3,432,100	1,609,222	1,581,465	1,032,823	1,850,644	536,309
Carey Act.....	1,189,937	603,098	2,573,574	2,285,321	-1,384,937	-1,620,313
Commercial.....	3,990,581	2,177,580	5,780,777	3,077,308	-1,787,196	-1,709,818
U. S. Reclamation Service.....	2,027,170	1,372,007	1,973,016	1,577,370	654,160	-204,769
V. S. Indian Service.....	932,985	648,434	870,068	700,150	63,917	-57,722
State.....	9,581	3,061	(1)	(1)	9,581	3,061
City.....	49,650	9,504	(1)	(1)	49,650	9,504
Other.....	13,144	5,908	(1)	(1)	13,144	5,908
Not reported.....	700	130	(1)	(1)	700	130

¹ A minus sign (-) denotes decrease.
² Not included in classification in 1910.

TABLE 13.—PER CENT DISTRIBUTION OF AREA IRRIGATED IN 1910, AREA ENTERPRISES WERE CAPABLE OF IRRIGATING IN 1920, AREA INCLUDED IN ENTERPRISES IN 1920, AND EXCESSES IN THESE ITEMS OVER AREA IRRIGATED IN 1919, BY SOURCE OF WATER SUPPLY.

SOURCE.	PER CENT OF TOTAL.				
	Area irrigated in 1919.	Area enterprises were capable of irrigating in 1920.	Area included in enterprises, 1920.	Excess of area enterprises were capable of irrigating in 1920 over area irrigated in 1919.	Excess of area included in enterprises over area irrigated in 1919.
Total.....	100.0	100.0	100.0	100.0	100.0
Streams, gravity.....	75.1	74.1	72.6	69.4	68.0
Streams, pumped.....	0.4	8.1	8.0	13.1	9.9
Streams, gravity and pumped.....	1.0	0.9	0.8	0.6	0.5
Wells, pumped.....	5.6	0.4	0.6	0.0	0.6
Wells, flowing.....	0.3	0.3	0.4	0.2	0.4
Wells, flowing and pumped.....	0.2	0.2	0.2	0.1	0.3
Lakes, gravity.....	0.5	0.6	0.9	0.7	1.3
Lakes, pumped.....	0.2	0.2	0.2	0.4	0.3
Springs.....	1.0	1.0	1.1	0.8	1.3
Stored storm water.....	0.5	0.9	0.9	1.8	1.3
City water.....	(1)	(1)	(1)	(1)	(1)
Sewage.....	(1)	(1)	(1)	(1)	(1)
Streams, gravity, and pumped wells.....	1.8	1.6	1.9	0.7	0.7
Streams, gravity, and flowing wells.....	0.4	0.4	0.6	0.3	0.7
Other mixed.....	5.2	5.4	6.4	5.9	7.8
Other, and not reported.....	0.1	0.1	(1)	(1)	(1)

¹ Less than one-tenth of 1 per cent.

Several of the states show actual decreases in the area included in enterprises, indicating the abandonment of extravagant schemes conceived during the boom period in irrigation development between 1900 and 1910, as well as a cessation in the undertaking of new enterprises.

The distribution of the area to which enterprises were capable of supplying water in 1920 and the area included in enterprises in 1920, and of the excesses in these items over the area irrigated in 1919 are shown in percentages, by source of water supply, in the preceding table. The distribution of the area irrigated in 1919 is repeated for the purpose of making comparisons.

CAPITAL INVESTED IN IRRIGATION ENTERPRISES.

The capital invested in irrigation works is presented in the United States summary and in the state reports, classified in the same way that acreage and other items are classified. The total investment and the average investment per acre in 1920 and 1910 are given by states in Table 14.

TABLE 14.—CAPITAL INVESTED IN IRRIGATION ENTERPRISES BY STATES: 1920 AND 1910.

STATE.	1920		1910		INCREASE, 1910-1920.	
	Amount.	Average per acre.	Amount.	Average per acre.	Amount.	Average per acre.
Total.....	\$407,657,328	\$26.81	\$321,454,008	\$15.85	\$376,203,320	\$10.90
Arizona.....	53,498,094	33.40	17,077,000	45.00	15,820,128	7.80
Arkansas.....	7,183,322	12.47	587,834	12.47	6,805,488	27.00
California.....	194,880,388	33.06	72,580,030	20.05	122,300,358	18.01
Colorado.....	88,302,442	22.00	60,636,443	14.10	31,665,999	8.71
Idaho.....	91,501,009	20.50	40,077,088	17.15	50,523,921	12.44
Kansas.....	2,067,881	30.47	1,365,593	9.75	701,818	20.72
Louisiana.....	14,003,181	10.30	0,820,100	12.40	7,204,015	6.80
Montana.....	52,143,303	18.04	22,070,958	10.42	20,172,405	8.52
Nebraska.....	13,000,185	24.73	7,708,310	18.17	9,110,875	6.56
Nevada.....	14,754,280	20.04	0,721,024	7.00	8,032,556	12.95
New Mexico.....	18,210,412	20.10	0,184,807	14.10	9,085,515	11.97
North Dakota.....	1,857,118	54.25	830,482	38.17	1,026,636	16.08
Oklahoma.....	181,325	15.66	47,200	7.38	104,125	8.27
Oregon.....	28,020,151	21.52	12,700,214	15.36	16,108,937	6.16
South Dakota.....	8,465,248	30.21	3,043,140	23.00	2,422,108	12.52
Texas.....	35,072,730	30.48	13,487,347	19.52	21,585,382	10.96
Utah.....	32,037,351	18.84	14,028,717	11.22	18,008,634	7.52
Washington.....	29,290,011	45.98	10,219,140	34.47	13,070,862	11.51
Wyoming.....	34,320,328	18.75	17,700,980	10.80	10,626,348	7.96

The capital invested in irrigation enterprises was more than doubled in the last decade. This is due principally to two causes: (1) Prices have been higher during this period than in any other period since irrigation construction on a large scale began, and this not only increased the cost of construction actually done during this period, but had a tendency to make owners of works built previously give higher estimates of capital invested than they would have done had prices been lower. (2) The bringing of water to land becomes constantly more difficult, and the easier projects are, naturally, carried out first, leaving the more difficult projects to be developed as the demand for agricultural products becomes greater.

The absolute increase in the average investment per acre was greater than in any previous period. This increase is due to the causes already enumerated, and to the fact that a considerable part of the capital invested during the last decade was for pumping equipment for supplementing the supply of water from canals and ditches for lands already under irrigation. Such investment and that for reservoirs to supply water in the late summer when streams are low are not accompanied by corresponding increases in the areas irrigated, and consequently raise the average investment per acre. At the same time, however, they increase and insure the returns from irrigated land to an extent that more than justifies the added investment per acre. Dependence upon the natural flow of streams, without storage or a supplemental water supply from wells, limits the crops grown to those with short growing periods, which, generally, are the less valuable crops.

In the discussion of water supply (pages 43, to 45) it is stated that future extension of the irrigated area will depend largely upon the storage of flood water and pumping from underground sources. This will be a more costly type of development, and consequently the average investment per acre is likely to continue to increase. In fact, the determining factor in fixing the limit of irrigation development is likely to be the amount that can be expended profitably in providing a water supply.

The data presented in the preceding pages show very large areas for which water is available that were not watered in 1919. The average investment per acre is computed on the basis of the areas to which enterprises were ready to supply water in 1920, consequently the average investment per acre actually watered and bringing a return was much higher than the figure reported. This fact is at the foundation of the financial difficulties of irrigation enterprises. The land actually producing must furnish whatever income there is. If the whole burden is thrown on this land, it is too heavy, and the farmer fails; and if the producing land bears only its proper share of the burden the investor must carry the rest, and the enterprise fails.

The capital invested in irrigation enterprises and the average investment per acre, based on the area enterprises were capable of irrigating in 1920, classified by the sources from which water is received, are given on page 52. The area that enterprises were capable of irrigating in 1920, classified in the same way, is given on page 46. The distribution of the areas enterprises were capable of irrigating and the capital invested, by the sources from which water is received, are shown, in percentages, in Table 15, which follows, with the average investment per acre, and comparison of the average for each class with the general average.

TABLE 15.—PER CENT DISTRIBUTION OF AREAS ENTERPRISES WERE CAPABLE OF IRRIGATING AND CAPITAL INVESTED, BY SOURCES FROM WHICH WATER IS RECEIVED.

SOURCE.	PER CENT OF TOTAL.		AVERAGE PER ACRE.	
	Area enterprises were capable of irrigating in 1920.	Capital invested to January 1, 1920.	Amount.	Per cent of general average.
Total.....	100.0	100.0	\$23.81	100.0
Streams, gravity.....	74.1	63.0	22.81	85.1
Streams, pumped.....	8.1	8.5	23.01	104.5
Streams, gravity and pumped.....	0.9	1.4	40.02	149.3
Wells, pumped.....	6.4	11.0	45.85	171.1
Wells, flowing.....	0.3	0.4	36.92	137.7
Wells, flowing and pumped.....	0.2	0.4	58.51	218.2
Lakes, pumped.....	0.2	0.3	33.06	142.0
Lakes, gravity.....	0.6	0.4	19.46	72.6
Springs.....	1.0	0.8	23.01	85.8
Stored storm water.....	0.9	2.2	67.47	261.7
City water.....	(¹)	(¹)	156.88	555.2
Sewage.....	(¹)	(¹)	52.85	197.1
Streams, gravity, and pumped wells.....	1.5	4.1	72.69	271.1
Streams, gravity, and flowing wells.....	0.4	0.4	27.38	102.1
Other mixed.....	5.4	6.9	34.67	129.3
Other, and not reported.....	0.1	0.1	84.86	204.6

¹ Less than one-tenth of 1 per cent.

As is the case with area irrigated, "streams, gravity," is by far the most important class in area enterprises were capable of irrigating in 1920, and in capital invested, while "streams, pumped," and "wells, pumped," are the other classes showing any considerable part of the area and capital. "Streams, gravity," is less important in capital invested than in area because of the fact that the average investment per acre for this class is less than the average for all classes.

In average investment per acre only one class—"lakes, gravity," which includes only about one-half of 1 per cent of the total area and capital—falls below "streams, gravity," and these two classes, and "springs"—which includes only 1 per cent of the total area—are the only classes for which the average investment is less than the general average. Streams, taken as a whole, show an average investment per acre of \$23.51, about 88 per cent of the general average; wells, taken as a whole, show an average of \$45.75 per acre, approximately double the average for streams; and the average investment for all pumped sources—streams, wells, and lakes—is \$35.92 per acre, 134 per cent of the general average.

While averages are shown for city water and sewage, the areas included are so small that the averages are not of much value. Eight other classes report less than 1 per cent of the total area, but the areas included are large enough to give the averages some value. All ten of these classes combined do not affect the general average greatly.

The outstanding fact shown by this table is that the cost of a water supply from wells is approximately double that of a supply from streams.

COST OF OPERATION AND MAINTENANCE.

The cost of operation and maintenance and the average cost per acre, classified by the sources from which water is received are given on page 52. The average cost per acre and a comparison of the cost for each source with the general average cost are given in Table 16.

TABLE 16.—PER CENT DISTRIBUTION OF COST OF OPERATION AND MAINTENANCE, 1919, BY SOURCE FROM WHICH WATER IS RECEIVED.

[When water is pumped, cost of operation and maintenance includes cost of fuel and attendance.]

SOURCE.	Per cent of total area for which cost is reported.	AVERAGE PER ACRE.	
		Amount.	Per cent of general average.
Total.....	100.0	\$2.43	100.0
Streams, gravity.....	73.0	1.25	51.4
Streams, pumped.....	7.1	6.50	267.6
Streams, gravity and pumped.....	1.2	2.33	95.9
Wells, pumped.....	6.5	19.07	414.4
Wells, flowing.....	0.2	2.77	114.0
Wells, flowing and pumped.....	0.2	8.04	330.9
Lakes, pumped.....	0.3	5.20	214.0
Lakes, gravity.....	0.6	1.30	53.5
Springs.....	0.9	1.53	67.1
Stored storm water.....	0.5	2.39	98.4
City water.....	(1)	20.73	852.1
Sewage.....	(1)	9.05	372.4
Streams, gravity and pumped wells.....	1.9	5.97	245.7
Streams, gravity and flowing wells.....	0.5	1.35	55.0
Other mixed.....	5.2	2.71	111.5
Other, and not reported.....	0.1	10.75	442.4

¹ Less than one-tenth of 1 per cent.

Disregarding city water and sewage, on account of the small areas covered, and "other mixed" and "other, and not reported," because they do not represent definite classes, the average cost per acre for every class that does not include pumping, except for flowing wells, is below the general average cost; while the average cost for every class that does include pumping, except for "streams, gravity and pumped," is more than double the general average cost.

Table 15, page 22, shows that the average first cost of a water supply from pumped wells is about double that of a gravity supply from streams, while Table 16, above, shows that the average cost of operation and maintenance for "wells, pumped," is about eight times as great as that for "streams, gravity," and that the cost of operation and maintenance for "streams, pumped," is more than five times as great as that for "streams, gravity."

The very low cost of a gravity supply from streams, as compared with a pumped supply, is accounted for in very large part by the fact that "streams, gravity," includes practically all of the early inexpensive ditches that water river-bottom lands, where both capital invested and cost of operation and maintenance are very low. Comparisons with large, modern enterprises taking water from streams by gravity, would be much less unfavorable to pumping enterprises.

DRAINAGE OF IRRIGATED LAND.

The irrigation of land has, in many cases, brought about the necessity for draining a part of the land. Where there is not good natural drainage it has brought the ground water near the surface, and in many places this has caused an accumulation of mineral salts, which are grouped under the term "alkali." In these cases artificial drainage will remove the surplus water and make it possible to wash out the alkali and restore the land to productivity.

The extent of the land damaged and the extent of the land for which drains have been installed are shown by states in State Table I, on pages 100 to 102.

About 5 per cent of all irrigation enterprises reported either land drained or land in need of drainage, or both. The area for which drains have been installed is about 8 per cent of the total area irrigated in 1919, and nearly as much more land is reported as in need of drainage. The area that has been injured by irrigation water is, therefore, slightly less than 16 per cent of the total area irrigated, and slightly more than 8 per cent of the total area included in enterprises.

The appearance of swampy places within irrigation projects has led to suggestions that drains should be put in when the irrigation works are built. The data given do not seem to justify such a plan. With only 5 per cent of the enterprises reporting any injured land, and only 8 per cent of the area in enterprises reported as injured, it is apparent that installing drains for all the land in irrigation enterprises as a part of the original construction would involve a very large expense for drains that are not needed, and this at a time when expense should be kept as low as possible. It seems much more logical to install drains as the necessity develops.

QUANTITY OF WATER USED.

The schedules used in both the Fourteenth and the Thirteenth Censuses called for the average volume of water entering canals, in second-feet; the total quantity of water entering canals, in acre-feet; and the total quantity of water delivered from canals, in acre-feet. In both censuses this inquiry was answered on only part of the schedules, and no attempts were made to supply missing information; nor were attempts made to convert measurements reported in one form into another form. Those reported in each form were tabulated together.

In the Fourteenth Census, the schedules showed whether water was measured, and the reports representing measurements and those not representing measurements were tabulated separately, and then combined. The results are shown on page 56, and in the state reports, and are summarized in the following table:

TABLE 17.—QUANTITY OF WATER USED IN 1919 AND 1909.

ITEM.	1919			1909
	Total.	Meas-ured.	Not meas-ured.	
Average number of acres irrigated per second-foot of water entering canals.....	41	60	23	62
Average quantity of water entering canals per acre.....	5.5	4.7	7.5	4.8
Average quantity of water delivered per acre.....	2.5	2.2	3.2	

The reports for 1919 cover a very much larger area than those for 1909. The results for 1909 correspond very closely with the results representing measurements for 1919, but differ quite widely from the averages of all reported.

The results from measurements in 1919 should be considered to be of the most value. They show an average of 4.7 acre-feet entering canals per acre irrigated, and 2.2 acre-feet delivered per acre irrigated, the quantity delivered being about 47 per cent of the quantity entering canals. These measurements do not represent the same canals, and the comparison is justified only on the assumption that each average is representative of all canals. The first average represents measurements of water diverted for nearly 8,000,000 acres, or over 40 per cent of the total area irrigated, and should be fairly representative. The average of quantity of water delivered represents about 4,000,000 acres, and is not so valuable as the other, but still is based on a sufficient area to justify its use. Assuming, then, that these averages are representative, 53 per cent of the water entering canals is either lost or wasted between the point of diversion and the point of delivery. In this connection "wasted" is not used in its usual sense, but as meaning turned out of the canal without being used for irrigation. Most of this water is not wasted, in the usual sense, but is available for use elsewhere.

It is worthy of note that the average number of acres irrigated per second-foot of average volume entering canals (41) is exactly the same as the average number of acres enterprises were capable of irrigating per second-foot of ditch capacity reported.

TYPES OF ENTERPRISES SUPPLYING WATER FOR IRRIGATION.

Classification of enterprises.—All the data relating to irrigation collected in connection with the Fourteenth Census have been classified by the types of enterprises supplying water for irrigation, and the results in detail are presented in the United States summary and in the state reports at the end of this volume. The types used are defined on page 12. In this section the field of usefulness of each type of enterprise as a

means of bringing land under irrigation is discussed in the light of the returns of the census. They are taken up in the order of their importance, as indicated by the area to which they supplied water in 1919. This order is shown, in percentages, in Table 18.

TABLE 18.—PER CENT DISTRIBUTION OF AREA IRRIGATED IN 1919 AND 1909, AND OF THE INCREASE IN AREA IRRIGATED 1909 TO 1919, BY TYPE OF ENTERPRISE.

TYPE OF ENTERPRISE.	PER CENT OF TOTAL AREA IRRIGATED SERVED BY EACH TYPE.		Per cent of total increase, 1909 to 1919.
	1919	1909	
Total.....	100.0	100.0	100.0
Individual and partnership.....	35.7	45.7	5.3
Cooperative.....	34.3	32.2	40.7
Irrigation district.....	9.5	3.7	27.2
Commercial.....	9.5	12.5	0.3
U. S. Reclamation Service.....	6.5	2.7	18.1
Carey Act.....	2.7	2.0	4.9
U. S. Indian Service.....	1.5	1.2	2.3
City.....	0.2	(1)	0.8
(Other).....	(3)	(1)	0.2
State.....	(3)	(1)	0.1
Not reported.....	(2)	(1)	(2)

¹Not included in classification in 1909. ² Less than one-tenth of 1 per cent.

Individual and partnership enterprises.—Individual and partnership enterprises occupy, as in 1909, the first place, in extent of area supplied with water, although the relative importance of such enterprises is decreasing. These enterprises supply water to more than one-third of the area irrigated and represent principally the earlier, easier, and cheaper types of construction. Since opportunities for such development are constantly diminishing, enterprises of this class must become relatively less important. However this class is particularly well adapted to irrigation from wells, and it is probable that both the number of enterprises and the area of land irrigated will continue to increase. The increase in the area irrigated by individual and partnership enterprises from 1909 to 1919 was less than 4 per cent, and this represented only a little more than 5 per cent of the total increase in area irrigated from 1909 to 1919. This poor showing for 1919 is due in part, at least, to the drouth in the northern part of the Great Plains region and the excessive rainfall in the southern part, since this semi-arid region is the section where such enterprises find their greatest usefulness. On the other hand, there is, in some sections, a tendency to consolidate small enterprises by the organization of stock companies or irrigation districts. This tendency is indicated by the relatively large increases in the areas irrigated by enterprises of these types and the increase shown for individual and partnership enterprises is, in fact, the net increase after deducting areas transferred to other classes.

The effect of the peculiar climatic conditions in 1919 is indicated by the large excesses in the areas that enterprises were capable of irrigating in 1920 and that were included in enterprises over the areas irrigated in 1919. The areas irrigated in 1919 were but 53 per cent of the total areas included in these enterprises, and but 74 per cent of the areas they were capable of supplying with water in 1920.

No doubt the area reported included in enterprises is greater than these enterprises can actually irrigate even when used to their fullest extent, but there is no way in which the extent of exaggeration can be measured. The area which all individual and partnership enterprises combined were capable of irrigating in 1920 was 71 per cent of the total area reported as included in such enterprises. At any time there will be some enterprises in the course of development, so that some of the excess represents land that will be irrigated when the enterprises are completed.

While individual and partnership enterprises represented 35.7 per cent of the area irrigated in 1919, and about the same percentage of the area enterprises were capable of irrigating in 1920, and the area included in enterprises, they represented only 22.2 per cent of the capital invested—that is, the average capital invested per acre for this class is below the general average investment per acre. The average investment per acre for all classes was \$26.81, and that for individual and partnership enterprises was \$16.71 or 62 per cent of the general average.

Irrigation works, classified by type of enterprise, are reported on page 57, and in the state reports at the end of this volume. The proportion of the total of each item belonging to individual and partnership enterprises is shown in the form of percentages in Table 19.

TABLE 19.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO INDIVIDUAL AND PARTNERSHIP ENTERPRISES.

ITEM.	Per cent of total.
Diverting dams.....number.....	85.2
Storage dams.....number.....	72.1
Main ditches:	
Number.....	89.9
Length.....miles.....	63.0
Capacity.....second-feet.....	42.2
Lateral ditches:	
Number.....	59.0
Length.....miles.....	26.8
Reservoirs:	
Number.....	83.0
Capacity.....acre-feet.....	11.1
Pipe lines, length.....miles.....	54.0
Flowing wells:	
Number.....	86.1
Capacity.....gallons per minute.....	88.4
Pumped wells:	
Number.....	94.8
Capacity.....gallons per minute.....	91.2
Pumping plants:	
Number.....	96.2
Engine capacity.....horsepower.....	71.7
Pumps—	
Number.....	93.4
Capacity.....gallons per minute.....	62.2

As is to be expected, the irrigation works belonging to individual and partnership enterprises are the smaller ones. This is particularly noticeable in the case of ditches, reservoirs, and pumping plants. Enterprises of this type own about 90 per cent of the main ditches, but these report only a little more than 40 per cent of the total capacity; they report 83 per cent of the reservoirs, but these have less than 12 per cent of the total capacity; they report 96 per cent of the pumping plants, but only 62 per cent of the pump capacity.

In regard to wells the situation is different. Irrigation from wells is naturally an individual matter, and enterprises of this class report 86 per cent of the flowing wells and 95 per cent of the pumped wells, and about the same proportion of the total capacities of wells.

Table 20 shows the historical development of enterprises of this type.

TABLE 20.—NUMBER OF INDIVIDUAL AND PARTNERSHIP ENTERPRISES, WITH AREA IRRIGATED IN 1919, CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Per cent of total.
Total.....	58,640	6,923,798	100.0
Before 1860.....	424	63,803	0.9
1860-1869.....	1,770	379,602	5.5
1870-1879.....	3,252	775,054	11.2
1880-1889.....	7,064	1,575,408	22.8
1890-1899.....	5,551	904,773	13.1
1900-1904.....	4,407	586,965	8.5
1905-1909.....	5,066	436,709	6.3
1910-1914.....	11,104	749,813	10.8
1915-1919.....	12,149	734,983	10.6
Not reported.....	7,853	716,888	10.4

The figures given in the table show that this type of enterprise reached its greatest importance, measured by the area irrigated, in the eighties, before the advent of large enterprises. As measured by the number of enterprises there has been great activity since 1910, but this represents principally pumping enterprises, supplying comparatively small areas.

Cooperative enterprises.—Cooperative enterprises supply water to about the same area as individual and partnership enterprises, the area served by them being also more than one-third of the total area irrigated—the two combined serve just 70 per cent of the total. Enterprises of this class showed the largest increase in area irrigated from 1909 to 1919, having more than 40 per cent of the total increase. This type of enterprise is not utilized for the development of new lands but rather for taking over enterprises of other types, particularly Carey Act and commercial enterprises, after works have been built and lands have been settled. The increase in the area served by cooperative enterprises represents in considerable part, therefore, trans-

fers to this type and more complete use of old enterprises rather than new enterprises.

The most common form of organization for cooperative enterprises is the stock company organized under the general incorporation laws of the state, with most of the stock owned by the water users. Water is apportioned on the basis of stock ownership, and the cost of the operation and maintenance is raised by assessments on the stock. There is not, in most cases, any necessary relation between amount of stock owned and area of land owned or irrigated, although there is a tendency for the two to be proportional. In fact, stock may be owned independent of land ownership, and it may be, and is at times, rented, the lessee receiving the water apportioned to the stock rented. This renders the stock good collateral for loans, and it is sometimes used in that way.

As stated previously, this type of organization is not well adapted for the construction of new enterprises of large size. In an arid region irrigation works must be built in advance of settlement, and consequently those who are to use the water are not there to organize the enterprises or build the works, except in the case of colonies backed by some powerful organization.

This type of organization for controlling irrigation works in the United States was originated in Utah, where the Mormon Church furnished the money necessary to support the settlers during the construction period, paid the settlers for work on construction in stock in the companies which were to control the enterprises, and, in return for its advances, took stock which was disposed of to later settlers. The famous Union Colony at Greeley, Colorado, was organized in much the same way, the settlers receiving stock in payment for work.

Commercial enterprises which have gone into land reclamation for profit have very generally adopted the plan of selling land and water, or water rights only, under contracts that provide for the irrigation works and water rights becoming the property of the purchasers of water rights, organized into stock companies, when the rights have been paid for. These enterprises then become cooperative. Carey Act enterprises almost universally operate on the same plan; and originally the United States Reclamation Service adopted this plan, but more recently it has changed and its enterprises are being organized into irrigation districts.

The cooperative enterprise has been found well adapted to the operation and management of irrigation enterprises, even those of large size. While in many cases it is possible for stock to get into the hands of persons who are not water users, this has not developed into a serious abuse, and the danger of abuse is more than offset by the advantages of being able to use the stock as collateral for loans. In some cases the stock is at-

tached to the land, and can not be owned apart from the land to which it is attached. In such cases the stock is proportioned to the acreage, and representation in the management is directly proportional to extent of land ownership.

The area irrigated in 1919 by cooperative enterprises was 78.3 per cent of the area these enterprises were capable of irrigating in 1920; that is, about 78 per cent of their effective capacity was utilized. This is higher than the average for all classes, 73.8 per cent. The area irrigated in 1919 was 61.9 per cent of the total area in enterprises of this class. This is considerably above the average for all classes. This is to be expected, since this class consists so largely of completed enterprises transferred to it.

Cooperative enterprises report 26.2 per cent of the total capital invested, with an average of \$21.78 per acre, based on the acreage enterprises were capable of irrigating in 1920. This average investment per acre is about 19 per cent less than the general average for all classes.

Table 21 shows, in percentages, what part of all irrigation works is controlled by cooperative enterprises.

TABLE 21.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO COOPERATIVE ENTERPRISES.

ITEM.	Per cent of total.
Diverting dams.....number.....	12.2
Storage dams.....number.....	20.0
Main ditches:	
Number.....	7.6
Length.....miles.....	21.9
Capacity.....second-feet.....	31.5
Lateral ditches:	
Number.....	20.7
Length.....miles.....	29.8
Reservoirs:	
Number.....	11.3
Capacity.....acre-feet.....	17.1
Pipe lines, length.....miles.....	23.6
Flowing wells:	
Number.....	5.5
Capacity.....gallons per minute.....	6.6
Pumped wells:	
Number.....	3.4
Capacity.....gallons per minute.....	6.2
Pumping plants:	
Number.....	2.6
Engine capacity.....horsepower.....	11.1
Pumps—	
Number.....	3.7
Capacity.....gallons per minute.....	9.7

The figures in the table show that the works belonging to cooperative enterprises are larger than the average, since they control larger percentages of the capacity than of the number.

Table 22 shows the history of enterprises of this class.

Like individual and partnership enterprises, cooperative enterprises showed their greatest activity, measured by area irrigated, in the eighties. The succeeding decade shows the next largest area, and the two preceding decades rank next. Since 1904 new enterprises of this type have not been so important.

TABLE 22.—NUMBER OF COOPERATIVE ENTERPRISES, WITH AREA IRRIGATED IN 1919, CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Per cent of total.
Total.....	3,477	6,465,090	100.0
Before 1860.....	198	176,618	2.7
1860-1869.....	373	793,432	12.3
1870-1879.....	348	842,649	13.0
1880-1889.....	696	1,745,743	27.0
1890-1899.....	492	762,540	11.8
1900-1904.....	282	783,969	12.1
1905-1909.....	304	628,782	9.7
1910-1914.....	288	380,223	5.9
1915-1919.....	262	169,222	2.6
Not reported.....	237	181,912	2.8

Irrigation districts.—Irrigation districts rank third in area irrigated, and second in the extent of increase in the area irrigated from 1909 to 1919. Like cooperative enterprises, districts are not well adapted to the development of new lands and, speaking generally, the increase in area reported under districts represents reorganizations rather than new enterprises. The figures given in Table 18 do not show the full extent of this movement, since the districts organized within United States Reclamation enterprises are not reported, because the Reclamation Service still controls these enterprises to a great extent, the districts serving merely as collecting agencies for the Reclamation Service. The large extent to which such reorganizations have taken place in the last decade is due very generally to the enactment of the Federal Farm Loan Act and the interpretation of that law. Under the Federal Farm Loan Act loans can be made only on first liens, while under the Reclamation Act as it was previously administered, under the Carey Act, and under most commercial enterprises, deferred payments on water rights were first liens on the lands to be irrigated, and, consequently farmers could get no loans from the Federal Farm Loan banks until their water rights were paid for—a period of 20 years under the Reclamation Act. Under irrigation district laws the cost of construction is covered by the issuance of bonds, with the principal and interest to be raised by taxation of the lands to be irrigated, rather than by mortgages to be enforced by foreclosure. It has been held that district bonds are not a bar to loans under the Federal Farm Loan Act.

A part of the increase in area irrigated by irrigation districts, however, represents new enterprises. This is particularly true in parts of California, where conditions are peculiar. It has been stated that the irrigation district is not adapted to the reclamation of new land, but this does not apply where districts are organized to supply water to land that has been farmed without irrigation. Unsettled desert land is not considered sufficient security for the capital necessary to

build works to bring water to the land, and consequently, districts composed of such lands can not sell bonds; but land already settled and under cultivation has, in some cases, sufficient value to serve as a basis for a bond issue, and bonds can be sold. That is the condition that prevails where districts have provided water for land already farmed but not previously irrigated.

The fundamental purpose of the organization of irrigation districts is the obtaining of funds for the construction or purchase of irrigation works, except for such reorganizations as have just been discussed. The inclusion of land within a district renders the land subject to taxation for interest and principal of bond issues, and also for the expense of operation and maintenance, and under state laws district taxes are to be collected in the same manner as state and county taxes, under the same penalties. This throws the burden of enforcing the bond lien, which is equivalent to a mortgage to secure deferred payments, upon the county officials, which is quite an advantage, from the standpoint of the holder of the lien.

An added advantage from the standpoint of the bond holder is that the whole bond issue is an obligation of the whole district. If any part of the land does not meet its share of the obligation, this deficit is added to the burden of the balance of the land.

Because of defaults in the payment of interest and principal on district bond issues, the markets for such securities have not been good, and the states have made many attempts to make irrigation district bonds more attractive to investors. The steps in this direction, taken by the several states, are shown in the following paragraphs, in which the state laws are analyzed from this viewpoint:

Arizona.—The original irrigation district law in Arizona was enacted in 1912. This law provided for the organization of districts under the supervision of county supervisors and for testing the validity of organizations and of bond issues in the courts, and irrigation district bonds were made legal investments for "all trust funds and for the funds of insurance companies, banks, banking institutions, and trust companies, and for the state and school funds, and whenever any money or fund may by law be invested in bonds of cities, counties, school districts, or municipalities in the state, such money or funds may be invested in said bonds of irrigation districts." (See sec. 5425, R. S., 1913.)

In 1921 there was created a state certification board, which is to investigate districts and certify their bonds.

No irrigation districts are reported in Arizona.

Arkansas.—Arkansas has no irrigation district law.

California.—Petitions for the organization of districts are submitted to the county supervisors and to the state engineer. If the supervisors find that a petition submitted to them conforms to the law, the state engineer is so notified. He then makes an investigation as to the feasibility of the project and reports to the supervisors. If the engineer reports that the water supply is not sufficient for the proposed district, the commissioner may still approve a district, but only after receiving a petition signed by an increased proportion of the landowners.

A law enacted in 1913 created an irrigation district bond commission and provided for the certification of bonds by the state comptroller, under certain conditions. Any district proposing the issuing of bonds may apply to have its bonds certified. Upon the receipt of such an application the commissioner examines: (1) The water supply, (2) the soil and its probable water requirements, (3) the feasibility of the plans for supplying water, (4) the reasonable market value of the water, water rights, and irrigation works of the district, (5) the reasonable market value of the land in the district, (6) whether the proposed bond issue, together with others that have been issued or proposed, exceeds 60 per cent of the value of the water, water rights, works, and land, and (7) the character and number of bonds proposed to be issued.

The commission reports to the state comptroller, and if it reports that the water supply is sufficient, that the plans are feasible, and that the proposed bond issue does not exceed 60 per cent of the value of the water, water rights, works, and land, the bonds are certified by the comptroller.

Bonds certified by the comptroller are legal investments for "all trust funds, and for the funds of all insurance companies, banks, both commercial and savings, and trust companies, and for the state school funds, and whenever any money or funds may, by law now or hereafter enacted, be invested in bonds of cities, cities and counties, counties, school districts, or municipalities in the state of California, such money or funds may be invested in said bonds of irrigation districts."

Colorado.—In Colorado all irrigation districts are organized under the supervision of the county commissioners. In 1921 Colorado provided for investigation of proposed districts by the state engineer and by a commission, and bonds certified by this commission were made legal investments for public and trust funds.

Idaho.—In Idaho irrigation districts are organized under the supervision of the county commissioners. When a petition for the organization of a district is filed it is submitted to the state engineer, who makes a report on it to the county commissioners. If the state engineer reports adversely the petition for organization is denied, unless a new petition signed by three-fourths of the landowners of the district is received. The board of directors of each district is required to report to the state engineer at least once a year, and to publish a financial statement on or before the first Tuesday in February of each year. In addition, the county commissioners have access to the books at all times.

In 1921 Idaho created a "Reclamation District Bond Commission," similar to the irrigation district bond commission of California, described above. The Idaho commission handles drainage district bonds as well as irrigation district bonds. The provisions of the Idaho law are similar to those of California except that the commission is to determine the reasonable "cost" of the water, water rights, and works belonging to the district rather than their "value"; is to determine the value of the land in the district "when supplied with the water that will be made available," and is to determine whether the aggregate amount of bonds proposed exceeds 50 per cent of the reasonable value of the "lands within the district, with the water right that will be made available." The essential differences seem to be that California takes into account the value of the water, water rights, and irrigation works, while Idaho does not, but, on the other hand, Idaho takes into consideration the prospective increased value of the land on account of irrigation, while California takes the value of the land as it stands. Idaho requires a margin of value above bond issues of 50 per cent, while California requires only 40 per cent. Bonds are certified by the state treasurer and are then legal investments for the same classes of funds as in California.

Kansas.—Kansas has an irrigation district law, but no districts are reported.

Louisiana.—Louisiana has no irrigation district law.

Montana.—In Montana irrigation districts are organized under the supervision of the county commissioners, the proceedings for

issuing bonds are reviewed by the courts, and the books of districts are open to state examiners. In 1919 there was created a public service commission under which districts may be organized.

A law enacted in 1921 provides for an irrigation bond commission, similar to the California commission, and makes bonds that have been certified legal investment for the same classes of funds as in California. After bonds have been certified no expenditures from funds raised may be made without approval of the commission.

Nebraska.—The Nebraska irrigation district law provides for the organization of districts under the supervision of the county commissioners. A copy of the petition for organization is filed with the state board of irrigation, and the secretary of the board (the state engineer) makes a report to the commissioners. After organization the board employs an engineer to make plans, and his plans are submitted to the state engineer. After the receipt of the report of the state engineer the directors of the district decide upon the amount of the bond issue needed, and call an election to decide whether the bonds shall be issued. The law provides a special court procedure for passing on the validity of the bond issue. There is no further provision for public supervision.

Nevada.—In Nevada irrigation districts are organized under the supervision of the county commissioners, and there is provision for submitting and testing the validity of organization and bond issues in the courts. A law of 1911 provided for submitting plans to the state engineer, but this was repealed in 1915. In 1921 Nevada created a bond commission similar to that of California.

New Mexico.—The New Mexico irrigation district law provides for the organization of districts under the supervision of the county commissioners. Each district is to employ an engineer, and his report is to be submitted to the state engineer, who is to determine the sufficiency of the water supply. If he finds that there is not enough water, he is to disapprove the report, and in such a case, no bonds can be issued. The validity of bond issues is to be tested in the courts.

North Dakota.—The provisions of the North Dakota irrigation district law regarding public supervision of the organization of districts and of bond issues are exactly like those of Nebraska. No districts are reported.

Oklahoma.—Oklahoma has an irrigation district law, but no districts are reported.

Oregon.—In Oregon districts are organized under the supervision of the county courts. Plans are submitted to the state engineer for his approval or disapproval. A commission similar to the California irrigation district bond commission was created in 1917. The law is similar to the California law except that the aggregate bond issues may not exceed 50 per cent of the value of the land, water, water rights, and irrigation works. Bonds are certified by the secretary of state, and, when certified, are legal investments for the same classes of funds as in California. In 1919 Oregon provided for state guarantee of bond interest, for not to exceed five years.

South Dakota.—South Dakota has an irrigation district law, but no districts are reported.

Texas.—Water improvement districts in Texas are organized under the supervision of the county commissioners. The proceedings for issuing bonds are reviewed by the court. When an action for this purpose is brought, notice is served on the state attorney general, who examines the proceedings and files an answer with the court. If the case is decided in favor of the district, the clerk of the court certifies this fact to the state controller of accounts, and on presentation of this certificate and the bonds of the district he registers the bonds, and attaches to each bond a certificate of the fact that the proceedings have been validated by the court.

Utah.—In Utah irrigation districts are organized under the supervision of the county commissioners, and organization and bond issues are validated by the court. In 1919, Utah enacted a law similar to the California law creating an irrigation bond commission. The provisions of this law are the same as those of the California law, and certified bonds are legal investments for the same funds.

When bonds have been certified in accordance with this law the district can make no expenditures without the consent of the bond commissioner.

Washington.—In Washington irrigation districts are organized under the supervision of the county commissioner. When a petition for the organization of a district is received by the county commissioners the state hydraulic engineer is notified and sits with the commissioner in an advisory capacity when a hearing is held on the petition. Proceedings for organization and bond issues are validated by the courts. There is no further state supervision.

Wyoming.—Wyoming enacted a new irrigation district law in 1920, which is entirely different from any previously existing irrigation district law. Under this law petition is filed with the district court of the county containing the largest part of the area of the proposed district, and all proceedings regarding organization and bond issues are handled by the court. There is no provision for participation by any public official.

The preceding analysis of the irrigation district laws shows the successive steps in attempting to give irrigation district bonds a standing to have been as follows: First, the organization of districts under public supervision, usually by the county commissioners; second, the validation of proceedings for organization and bond issues by the courts; third, examination and report upon plans by the state engineers but without authority to take any action; fourth, the making of irrigation district bonds legal investments for trust funds and public funds; fifth, the certification of bonds by public commissions after examination of the enterprises; sixth, giving the bond commissions supervision over expenditures from funds obtained by the sale of certified bonds. Oregon has gone one step further and guarantees interest on district bonds for the first five years. No other state has gone so far as to guarantee bonds in any way.

Still further attempts to utilize district bonds for financing the construction of irrigation works have been made by enacting legislation in the states providing for issuing bonds to the United States in payment for the construction of irrigation works by the Federal Government and by attempting to get Federal legislation authorizing the acceptance of such bonds by the Federal Government, and the issuance of its own bonds, to secure funds, which, in turn, would be repaid with the payments on the district bonds. No such law has been enacted, but many bills providing for such laws have been introduced and urged. This would amount to the guaranteeing of district bonds by the Federal Government, since the Government could not afford to default in its payments, even if the districts defaulted in the payments on the bonds on which the Government bonds were based. Except in California and Oregon the laws providing for the certification of bonds are of so recent date that the census returns do not show their results, if there are any. The returns for California show 19 districts begun in the period from 1915 to 1919, including

238,000 acres. This is much greater activity than has been shown at any previous time, and may be due, in part, at least, to this law. Oregon reports in the same period 11 districts, including about 145,000 acres, which is nearly one-half of all the districts organized in the state, and about one-third of the area included in districts.

No other state shows any marked activity in the organization of districts, and consequently it seems that the results in California and Oregon may be attributed to their laws.

In 1919 irrigation districts supplied 9.5 per cent of the total area irrigated, which is less than one-third of the area served by either individual and partnership enterprises or cooperative enterprises. In 1909, however, districts served only 3.7 per cent of the total area, showing a large increase in relative importance. In fact, districts showed 27.2 per cent of the total increase in area irrigated from 1909 to 1919. This increase has been discussed (p. 16).

The area irrigated by districts in 1919 was 72 per cent of the area they were reported capable of supplying in 1920, and 53 per cent of the area included in district enterprises. These figures indicate that districts were in about the same condition as the average for all enterprises, considered as a whole. Irrigation districts reported 9.5 per cent of the total area irrigated in 1919, and about the same percentage of the area enterprises were capable of irrigating in 1920 and the area in enterprises. On the other hand, they represented 12.7 per cent of the capital invested to January 1, 1920, indicating an average investment per acre higher than the general average. The average investment per acre, based on the area districts were capable of irrigating in 1920, was \$34.98, while the general average for all enterprises was \$26.81.

The percentages of all irrigation works of all classes belonging to irrigation districts are given in Table 23.

TABLE 23.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO IRRIGATION DISTRICTS.

ITEM.	Per cent of total.
Diverting dams.....number.....	1.1
Storage dams.....number.....	2.0
Main ditches:	
Number.....	0.9
Length.....miles.....	4.8
Capacity.....second-feet.....	8.2
Lateral ditches:	
Number.....	4.3
Length.....miles.....	10.8
Reservoirs:	
Number.....	1.1
Capacity.....acre-feet.....	7.9
Pipe lines, length.....miles.....	9.2
Flowing wells:	
Number.....	6.6
Capacity.....gallons per minute.....	1.3
Pumped wells:	
Number.....	0.3
Capacity.....gallons per minute.....	0.6
Pumping plants:	
Number.....	0.3
Engine capacity.....horsepower.....	5.8
Pumps—	
Number.....	0.9
Capacity.....gallons per minute.....	5.1

The table shows that the works belonging to irrigation districts are larger than the average, since the percentages of capacities are larger than the percentages of the total numbers of works of various kinds.

Table 24 shows the history of irrigation district enterprises.

TABLE 24.—NUMBER OF IRRIGATION DISTRICT ENTERPRISES, WITH AREA IRRIGATED IN 1919 CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Per cent of total.
Total.....	236	1,849,874	100.0
Before 1880.....	1	2,000	0.1
1880-1889.....	9	93,672	5.1
1870-1879.....	12	235,327	12.8
1860-1869.....	41	395,562	21.5
1850-1859.....	44	397,568	21.6
1840-1849.....	16	62,270	3.4
1830-1839.....	44	254,108	13.8
1820-1829.....	29	166,569	9.0
1815-1819.....	49	294,884	11.1
Not reported.....	11	28,914	1.6

It is evident that in some instances districts have given as the date of beginning the date on which the enterprises that have been reorganized into districts were begun, rather than dates when the districts were organized. The eighties and nineties were the periods of greatest activity in the beginning of enterprises that are now controlled by districts. This period was followed by a slump from 1900 to 1905, due to defaults of existing districts, a revival between 1905 and 1909, with another slump from 1910 to 1914. Within the last five years there has been some revival, due to increased public supervision, reorganizations to permit of loans under the Federal Farm Loan Act, and other causes previously discussed.

Commercial enterprises.—Commercial enterprises report the same percentage of the total area irrigated in 1919 as that reported for irrigation districts, 9.5 per cent. They show, however, a decrease in relative importance since 1909, when they reported 12.5 per cent of the total area irrigated. While cooperative enterprises and districts are continually gaining in relative importance by the reorganization of other enterprises into these forms, commercial enterprises are losing in relative importance by the same process. Notwithstanding this loss commercial enterprises rank among the leading types, measured by the area irrigated in 1919, and much higher in the area actually reclaimed by such enterprises, now reorganized into other forms.

Commercial enterprises reported practically no increase in area irrigated from 1909 to 1919, and an actual decrease during the same period in area enterprises were capable of irrigating and the area in enterprises. Table 26, page 31, shows considerable areas in enterprises begun between 1910 and 1915, but almost a complete cessation in the organization of such enterprises since 1915.

The original plan of operation of commercial enterprises was to build irrigation works and sell water rights that carried with them no interest in the works, but merely entitled the purchasers to obtain water upon the payment of annual charges. This was the plan on which most of the large irrigation enterprises promoted between 1870 and 1895 operated. There were so many abuses in selling rights to more water than could be delivered, in unfair contracts, and in excessive annual charges, that from time to time the states passed laws prohibiting the sale of rights beyond the capacities of canals, providing for the regulation of rates by some public authority, and, in some states, prohibiting the sale of water rights of this type. In most states rates are regulated by the county commissioners, but in California and Nebraska they are regulated by the state railway commissions.

The restrictive legislation referred to and the general financial failure of such enterprises have led to the abandonment of this plan of operation, and in recent years commercial enterprises sell rights which carry an interest in the works and water supply under contracts that provide that the works and rights shall become the property of the water users. Under this plan organization as a commercial enterprise is only a stage in the development of a cooperative enterprise.

The area irrigated in 1919 by commercial enterprises was 65 per cent of the area these enterprises were capable of irrigating in 1920, indicating that these enterprises are not so fully utilized as those of the types previously discussed. The area irrigated in 1919 was but 46 per cent of the land in the enterprises. The excess in area in enterprises over area irrigated is by far greater in the more recent enterprises, indicating that it represents enterprises in the process of development.

The part of all irrigation works that belongs to commercial enterprises is shown in Table 25.

TABLE 25.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO COMMERCIAL ENTERPRISES.

ITEM.	Per cent of total.
Diverting dams.....number.....	0.8
Storage dams.....number.....	3.0
Main ditches:	
Number.....	0.8
Length.....miles.....	6.1
Capacity.....second-feet.....	8.6
Lateral ditches:	
Number.....	7.7
Length.....miles.....	13.2
Reservoirs:	
Number.....	2.7
Capacity.....acre-feet.....	11.1
Pipe lines, length.....miles.....	9.5
Flowing wells:	
Number.....	1.3
Capacity.....gallons per minute.....	2.8
Pumped wells:	
Number.....	0.9
Capacity.....gallons per minute.....	1.4
Pumping plants:	
Number.....	0.6
Engine capacity.....horsepower.....	8.9
Pumps:	
Number.....	1.4
Capacity.....gallons per minute.....	18.8

Commercial enterprises report 12.3 per cent of the capital invested in all enterprises, with an investment per acre to which they were capable of supplying water in 1920 of \$30.62, as compared with \$26.81 for all classes.

The table shows that for every item the percentage of the total capacity exceeds the percentage of the total number, indicating that the works belonging to commercial enterprises exceed the average size.

In recent years many commercial enterprises have secured control of tracts of land, and sell the land with the works and rights. This form of organization is particularly well adapted to this type of development, operating on a comparatively small scale.

The historical development of commercial enterprises is shown by Table 26.

TABLE 26.—NUMBER OF COMMERCIAL IRRIGATION ENTERPRISES, WITH AREA IRRIGATED IN 1919, CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Percent of total.
Total.....	309	1,802,599	100.0
Before 1860.....	18	13,877	0.8
1860-1869.....	8	9,535	0.5
1870-1879.....	36	726,505	40.3
1880-1889.....	24	273,089	15.1
1890-1899.....	53	279,817	15.5
1900-1904.....	38	178,311	9.9
1905-1909.....	37	168,481	9.3
1910-1914.....	52	113,050	6.3
1915-1919.....	26	18,313	1.0
Not reported.....	17	21,621	1.2

The largest development of commercial enterprises was coincident with the beginning of large-scale irrigation enterprises in 1870, and commercial enterprises continued to be of importance, although on a decreasing scale, until 1914. Since 1914 commercial enterprises have ceased to be important, because of the difficulty in financing such enterprises.

United States Reclamation Service enterprises.—The United States Reclamation Service ranks fifth among the types of enterprises in the extent of the area irrigated in 1919, having 6.5 per cent of the total.

This does not represent the full extent of the work of the Reclamation Service, since it supplies stored water to lands receiving their principal supply from other sources. The area thus furnished a partial supply of water in 1919 was slightly less than one million acres. On the other hand, some of the land reported by the Reclamation Service was supplied with water by enterprises of other types that have been incorporated into the reclamation enterprises. In extent of increase in area irrigated from 1909 to 1919 the Reclamation Service ranks third, with 18.1 per cent of the total. This increase represents a real extension in the area irrigated, and not transfers from other enterprises, as is the case with cooperative enterprises and irrigation districts.

The Reclamation Service reports about the same percentages of the total area all enterprises were capable of irrigating in 1920 and of the total area included in all enterprises that it does of the area irrigated in 1919, 6.5 per cent and 7.3 per cent, respectively.

The area irrigated in 1919 was 74.6 per cent of the area enterprises were capable of irrigating in 1920, showing that the effective capacity of the United States Reclamation Service enterprises was more fully utilized than that of most other types of enterprise. The area irrigated in 1919 was but 47.8 per cent of the area included in enterprises. This low percentage is due to the fact that the Reclamation Service is actively engaged in construction work and very few of its enterprises are completed.

The United States reclamation law was enacted in 1902. The original law provided for the construction of irrigation works with the proceeds from the sale of public lands, after deducting certain amounts, and for the repayment of the cost by the water users in 10 annual installments. These repayments were to go into the reclamation fund, to be used in building additional works, thus creating a revolving fund continually augmented by the proceeds from the sale of lands. To this fund was added in 1914 a loan from the Treasury of \$20,000,000, which is to be repaid, and consequently does not form a part of the revolving fund. Table 27, taken from the Nineteenth Annual Report of the Reclamation Service (p. 57), shows the amounts which have gone into the reclamation fund from 1901 to June 30, 1920.

TABLE 27.—ACCRETIONS TO THE RECLAMATION FUND FROM ALL SOURCES TO JUNE 30, 1920.

FISCAL YEAR.	Total.	Sale of public lands.	Sale of town lots.	Bond loan.	Miscellaneous collections and repayments.
Total.....	\$153,657,583.43	\$100,300,195.79	\$493,329.63	\$20,000,000	\$32,854,058.01
1901.....	8,144,821.91	8,144,821.91			
1902.....	4,585,520.53	4,585,520.53			
1903.....	8,714,238.97	8,713,996.60			242.37
1904.....	6,826,964.43	6,826,253.59			710.84
1905.....	4,805,854.24	4,805,515.39			1,338.85
1906.....	5,189,261.13	5,166,336.50			22,924.63
1907.....	9,072,116.16	7,914,131.71	61,535.00		96,449.45
1908.....	9,061,540.18	9,430,573.98	12,894.06		518,102.14
1909.....	8,519,885.24	7,758,496.81	10,017.85		751,400.58
1910.....	8,810,876.86	7,028,188.73	60,112.86		1,722,575.27
1911.....	8,239,355.55	6,135,547.76	69,468.80		2,034,338.99
1912.....	8,127,546.68	5,657,498.88	15,224.10		2,454,823.70
1913.....	6,115,808.91	3,737,910.55	17,784.74		2,360,113.62
1914.....	9,717,890.35	3,460,451.63	15,280.25	3,500,000	2,742,158.47
1915.....	14,177,564.75	3,208,037.73	18,436.28	8,500,000	2,391,070.74
1916.....	8,518,265.80	2,648,077.74	21,189.28	5,500,000	2,349,018.78
1917.....	7,378,899.37	2,865,286.34	31,250.15	3,500,000	3,182,453.08
1918.....	9,073,087.21	2,352,650.65	60,921.56	3,000,000	3,159,445.00
1919.....	5,877,034.04	1,859,408.88	55,372.49		3,962,252.67
1920.....	7,600,030.92	2,644,334.88	43,813.21		4,911,882.83

¹ Of this total, \$9,286,469.16 is reported as repayments on construction charges; \$6,462,557.23 as operation and maintenance charges; and \$17,115,031.62 as miscellaneous collections. These items are not reported separately by years.

The same report gives the gross construction cost as \$126,140,986.18 and the operation and maintenance cost as \$18,588,049.85. The gross construction cost reported here is slightly less than the capital invested

as reported by the census. The report states that this difference is due "to a combination of items included in disbursements but not in cost and items included in cost but not in disbursements." The reported repayments on construction charges are 7.4 per cent of the gross construction cost. From this it appears that the "revolving fund" feature of the reclamation fund is as yet not realized.

Since the date of the census, and therefore not affecting the reclamation fund as reported above, Congress has provided that 52.5 per cent of the receipts under the oil-leasing act and 50 per cent of the receipts under the Federal power act shall be paid into the reclamation fund.

For the purpose of permitting of more construction of irrigation works than the reclamation fund provides for, many bills have been introduced in Congress providing that the Federal Government may accept the bonds of irrigation districts in payment for construction work, or in advance of construction, and issue its own bonds, to be repaid from the payments on the district bonds, for the purpose of obtaining funds for construction. (See page 29.) No such law has been enacted, however.

As stated previously, the reclamation law originally provided that the cost of construction should be repaid in not more than 10 annual installments. In 1914 Congress enacted the so-called "extension act," which provided for extending payments over a period of 20 years instead of 10. In both cases the Secretary of the Interior was authorized to fix the time when the payments shall begin, and in neither case is interest charged on deferred payments. The extension of the time during which payments may be made and the fact that for several projects the Secretary of the Interior has not yet fixed the time when payments shall begin account for the smallness of the amount received from the repayments of construction charges.

Projects for which the payments have not begun are operated on temporary rental agreements. The report referred to above gives (p. 52) the receipts from water rentals to June 30, 1920, as \$6,149,617.27.

The census schedules returned by the Reclamation Service show the total capital invested to January 1, 1920, to be \$129,509,819, which is 18.6 per cent of the total capital invested in enterprises of all classes. On the basis of the area capable of being irrigated in 1920, this is an average investment per acre of \$77.06. However, the Reclamation Service supplied stored water to nearly 1,000,000 acres receiving their principal supply of water from other sources. A part of its expenditures should be charged to these lands, but the census returns do not show how much. Including the total area supplied with stored water in the area used in computing the average investment per acre would give an average of \$48.31 per acre. The correct average lies between these two sums, above rather than

below the mean of the two. Probably \$65 per acre approximates the correct amount. The average for all enterprises is \$26.81, and the average for the Reclamation Service is about two and one-half times the general average.

The average cost per acre of operation and maintenance for Reclamation Service enterprises was \$2.20, which is but 91 per cent of the average cost of all enterprises.

With reference to the ultimate control of Reclamation Service enterprises the law contains the following provision (sec. 6):

Provided, That when the payments required by this act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: *Provided*, That the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress.

In the earlier years of the operation of the Reclamation Act the Secretary of the Interior required the organization of water-users' associations with which he dealt in matters relating to the various enterprises, but in more recent years he has preferred the organization of irrigation districts. Some of the enterprises are organized in one form and some in the other, but none has yet reached the stage described in the law. In either case the local organizations act as collecting agents for the Reclamation Service. As pointed out in the discussion of districts, this form of organization has the advantage that the deferred payments represented by district obligations do not bar settlers from obtaining loans under the Federal Farm Loan Act.

While the United States Reclamation Act nominally relates to public lands, it provides for the inclusion of private lands in reclamation enterprises, and therefore is available for supplying water to lands of either class.

The Reclamation Act originally provided in general for expenditures in the various states in proportion to the funds arising from the sales of public lands within the states. This restriction was later removed, leaving the allotment of funds to the discretion of the Secretary of the Interior. The act extending the period of repayment to 20 years provided that after July 1, 1915, expenditures from the reclamation fund should not be made except out of appropriations made annually by Congress, and since that date Congress has made annually appropriations for specific projects.

The percentage of the total of all irrigation works that belongs to the Reclamation Service is shown in Table 28.

For only one item does the number credited to the Reclamation Service equal 1 per cent of the total, but

in capacity its works rank much higher. This is particularly noticeable in the case of reservoirs, where the number is less than 1 per cent of the total, while the capacity is only a little less than 50 per cent of the total.

TABLE 28.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO UNITED STATES RECLAMATION ENTERPRISES.

ITEM.	Per cent of total.
Diverting dams.....number.....	0.2
Storage dams.....number.....	1.0
Main ditches:	
Number.....	0.2
Length.....miles.....	1.9
Capacity.....second-feet.....	5.2
Lateral ditches:	
Number.....	5.6
Length.....miles.....	10.2
Reservoirs:	
Number.....	0.6
Capacity.....acre-feet.....	46.7
Pipe lines, length.....miles.....	2.0
Pumped wells:	
Number.....	0.2
Capacity.....gallons per minute.....	0.3
Pumping plants:	
Number.....	0.1
Engine capacity.....horsepower.....	1.9
Pumps—	
Number.....	0.2
Capacity.....gallons per minute.....	2.7

The activity of the Reclamation Service, measured by the area irrigated in 1919 in enterprises begun at various dates, is shown by Table 29.

TABLE 29.—NUMBER OF UNITED STATES RECLAMATION SERVICE ENTERPRISES, WITH AREA IRRIGATED IN 1919, CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Per cent of total.
Total.....	74	1,241,016	100.0
1900-1904.....	16	368,946	29.7
1905-1909.....	37	761,361	61.3
1910-1914.....	10	102,369	8.2
1915-1919.....	5	7,644	0.6
Not reported.....	6	705	0.1

The reclamation law was enacted in 1902, and more than 90 per cent of the land irrigated in 1919 is in enterprises begun between 1902 and 1910. For many years it has been the policy of the service, as well as of Congress, to complete existing projects rather than begin new ones. Table 12 on page 21, shows that the area included in these enterprises but not irrigated in 1919 exceeds the area irrigated in 1919. In other words, the area irrigated by Reclamation Service enterprises can be doubled without the undertaking of any new enterprises.

Carey Act enterprises.—Carey Act enterprises show the smallest area irrigated in 1919 of any of the types of enterprise engaged primarily in supplying water for irrigation—only 2.7 per cent of the total; and they show also only about 5 per cent of the total increase in area irrigated during the last decade. Here again,

the figures do not present the whole truth, since under state laws, Carey Act enterprises pass to cooperative enterprises as soon as they become well developed.

The area irrigated in 1919 was 65 per cent of the area enterprises were capable of irrigating in 1920, and 44 per cent of the area included in enterprises, as compared with general averages of 74 per cent, and 53 per cent for enterprises of all types. The poor showing of Carey Act enterprises as to utilization of their full capacity, as compared with enterprises of other classes, is due in part, at least, to the fact that they, like commercial enterprises, represent only one stage in the development of cooperative enterprises. As soon as an enterprise is fairly well developed it is reorganized into a cooperative enterprise and would not be reported as a Carey Act enterprise.

Carey Act enterprises report 4.7 per cent of the total capital invested in irrigation enterprises, with an average of \$40.63 per acre, while the average per acre for all enterprises is \$26.81.

The Federal Carey Act is very general in its terms, the plan of operation being left largely to the several states. The states are authorized to make all contracts necessary for the reclamation of the lands, but are prohibited from leasing any land, from disposing of it in any way except to secure its reclamation, cultivation and settlement, and from disposing of more than 160 acres to any one person.

The state laws governing operations under the Carey Act differ much in detail but are alike in general plan. All operations are placed under the supervision of state boards. Any person or corporation desiring to reclaim land under this law applies to the proper board, specifying the lands which it is desired to have segregated, and describing the proposed plan of reclamation. If the application is approved by the state board, it is submitted to the General Land Office, and if it is approved there the land is segregated and set aside to be disposed of in accordance with a contract entered into by the state and the applicant. This contract provides for the construction of works and fixes the terms on which water rights may be sold to settlers, one of the conditions being that the rights sold shall carry an interest in the works, so that when rights are paid for the works and rights become the property of the purchasers of rights. On its part the state agrees to sell lands only to parties who have entered into contract with the applicant for the purchase of water rights. The plan adopted for passing title from the applicant to the purchaser of water rights and land is to issue with the rights stock in a new company which becomes effective upon the completion of specified payments. The Federal Government patents the land to the state, and the state issues title to the purchaser, when his payments are made.

The Federal law authorizes the states to create liens on the lands "for the actual cost and necessary expense of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers," and for this purpose the Government may pass title to the states as soon as an adequate water supply is made permanently available. This, however, is not the usual plan. Water rights are sold on deferred payments, and bonds are sold, secured by the notes for these deferred payments and the settlers' interest in the land. Settlers agree to give mortgages on the land as soon as they get title, but until that time the bonds are secured only by the settlers' interest in the land. The usual practice has been for the states to apply for patent only when the settlers have fulfilled the conditions entitling them to patent; consequently, up to that time the title to the land is in the Federal Government and it is not liable for the bonds.

Table 30, compiled from the annual reports of the General Land Office, shows the areas applied for, segregated and patented under the Carey Act from 1911 to 1920. As the amounts are cumulative, they show in fact what has been done under this act from the date of its passage in 1894.

TABLE 30.—AREAS APPLIED FOR, SEGREGATED, AND PATENTED UNDER THE CAREY ACT (ACRES).

YEAR.	APPLIED FOR.		SEGREGATED.		PATENTED.	
	To date.	During year.	To date.	During year.	To date.	During year.
1911	7,116,239	975,529	3,193,314	328,795	388,494	69,549
1912	7,301,637	184,697	3,291,251	97,917	474,000	85,596
1913	7,773,359	471,657	3,685,992	394,761	430,048	35,171
1914	7,682,445	21,796	3,662,230	6,238	469,654	39,008
1915	7,781,110	98,665	3,795,445	13,215	691,573	141,519
1916	7,735,846	54,338	3,706,367	2,922	761,455	159,962
1917	7,741,993	6,116	3,711,615	5,247	803,519	42,664
1918	7,797,631	55,698	3,755,429	43,814	815,163	11,644
1919	7,797,631		3,758,965	3,536	823,264	68,103
1920	8,073,953	276,343	3,781,649	22,645	888,793	5,527

Except for the application for something over 500,000 acres in 1920—the application coming from Idaho—there have been few applications and fewer segregations since 1913. The issuing of patents represents progress on older enterprises, rather than the undertaking of new ones.

The Carey Act applies only to public lands, and as large bodies of public land susceptible of irrigation become more scarce there is less and less opportunity for development under this act. It has been stated that desert lands in irrigation districts are not considered sufficient security for bonds to cover the cost of construction of irrigation works, where these bonds are a tax lien on the lands, and Carey Act bonds have even less security, since they do not become a lien on the lands until the settlers on the lands secure title to their holdings. Many Carey Act enterprises have

failed, and this has given Carey Act bonds a poor standing in the market. Because of this and the fact that the areas of public land fitted to be reclaimed under the Carey Act are diminishing, it appears that the Carey Act will not be made use of to so large an extent as it has in the past.

Table 31 shows what part of the irrigation works of the country are controlled by Carey Act enterprises. The table shows that Carey Act enterprises control an insignificant part of the irrigation works.

TABLE 31.—PERCENTAGE OF ALL IRRIGATION WORKS BELONGING TO CAREY ACT ENTERPRISES.

ITEM.	Per cent of total.
Diverting dams.....number..	0.2
Storage dams.....number..	0.7
Main ditches:	
Number.....	0.1
Length.....miles..	1.4
Capacity.....second-feet..	3.0
Lateral ditches:	
Number.....	1.0
Length.....miles..	4.5
Reservoirs:	
Number.....	0.4
Capacity.....acre-feet..	4.2
Pipe lines, length.....miles..	0.7
Flowing wells:	
Number.....	0.2
Capacity.....gallons per minute..	0.6
Pumping plants:	
Number.....	(¹)
Engine capacity.....horsepower..	0.1
Pumps—	
Number.....	0.1
Capacity.....gallons per minute..	(¹)

¹ Less than one-tenth of 1 per cent.

Table 32 shows the acreage irrigated by Carey Act enterprises in 1919, distributed by date of beginning.

TABLE 32.—NUMBER OF CAREY ACT ENTERPRISES, WITH AREA IRRIGATED IN 1919, CLASSIFIED BY DATE OF BEGINNING.

DATE OF BEGINNING.	Number of enterprises.	AREA IRRIGATED IN 1919.	
		Acres.	Per cent of total.
Total.....	42	521,829	100.0
1890-1899.....	7	50,855	9.7
1900-1904.....	7	243,655	46.7
1905-1909.....	19	221,256	42.4
1910-1914.....	7	6,103	1.2
1915-1919.....	2	50	(¹)

¹ Less than one-tenth of 1 per cent.

This table shows, as did that compiled from the reports of the General Land Office, that there has been little activity under the Carey Act since 1910.

Other types of enterprises.—The other types of enterprises included in the classification are not engaged primarily in supplying water for irrigation.

The United States Indian Service supplies water to land in Indian reservations, and the land to which it supplied water in 1919 was 1.5 per cent of the total.

State enterprises have some significance because they include a state land-settlement project in California, the first of its kind in the United States. In

this case the state has prepared so-called "ready-made farms," equipped with buildings, fences, and other improvements, as well as irrigation and drainage facilities. The lands are sold on long-time, amortized payments, and there has been a high degree of state supervision and leadership in the affairs of the colony. A second colony has been established in California, but was not sufficiently advanced to be reported in the census. This plan of land settlement, backed by both state and Federal governments is being urged, but has not been adopted, except in California.

WATER RIGHTS.

In the arid sections of the United States the right to use water is the most important factor entering into the value of land. Yet the development of the West was begun without an adequate appreciation of the value of titles to water rights, and without adequate legislation for perfecting titles, and according to the returns of the Fourteenth Census only a little more than one-half of the land irrigated is served by enterprises whose titles to water are defined and recognized by any legally constituted authority. Nearly \$700,000,000 has been invested in irrigation enterprises, and land values of many times that amount are dependent on rights to water, only about one-half of which are properly defined. The laws of the several states relating to this subject are summarized on pages 47 to 48, and are stated more in detail in the state reports at the end of this report.

There are in the Western states two general theories as to water rights, one known as the doctrine of appropriation—that water may be taken from streams for use on land without reference to its bordering on the streams—and the other known as the riparian doctrine—that water from a stream may be used only on land bordering that stream. The doctrine of appropriation is recognized in all of the states where irrigation is generally practised, while the riparian doctrine is recognized to a limited extent in several of the states. However, less than 2 per cent of the land irrigated in 1919 is reported to be served by riparian rights. Consequently, it may be stated that practically all of the rights to water for irrigation rest on the doctrine of appropriation.

The fundamental elements of the doctrine of appropriation are as follows:

1. Water may be taken from streams for beneficial uses on lands not bordering the streams from which it is taken.
2. The appropriation (the taking of the water) must be for some useful or beneficial purpose.
3. Among appropriators the first in time is the first in right. That is, when there is not water enough for all, the appropriators are to be supplied in the order of the dates of their first use of water, up to the limit of their rights.

4. When the use ceases the right ceases.

The states have assumed the right under their police powers to control the acquirement and enforcement of water rights, and the United States Supreme Court has recognized this right on the part of the states. (*Kansas v. Colorado*, 206 U. S., 46.)

Notwithstanding that all Western states have provided for some public control over the acquirement of water rights, they have all recognized rights acquired without conforming to the legal requirements or prior to the establishment of such requirements: that is, by "appropriation and use." The reports show that 13.1 per cent of the land irrigated in 1919 was served by rights of this class that have not been defined or otherwise made of record.

The first step in public control was the enactment of laws requiring the posting of notices at the points of intended diversion stating what was claimed, and the filing of copies of these notices in county records. In several states the laws required also the filing of claims for rights acquired prior to the enactment of the laws. The dates of the enactment of laws requiring posting and filing of notices or the filing of claims are shown on page 47. Since "beneficial use" is essential to the acquirement of a right and to its maintenance, it is obvious that the filing of a claim does not give title and the filing is merely evidence of an intent to acquire a right and not evidence of the right itself. Consequently, rights acquired in this way are not defined as they are acquired. The area irrigated in 1919 under rights initiated in this way and not otherwise defined is 14.4 per cent of the total area irrigated.

All of the states covered by the census of irrigation, except Arkansas, Colorado, Kansas, Louisiana, and Montana, have provided for a more orderly and efficient system of the acquirement of rights. The dates of the enactment of their laws making this provision are shown on page 48. These laws require a party wishing to acquire a right to apply to some state board or official for a permit to take a specified quantity of water from some source, stating the nature and the place of use. The approved application becomes a permit. Proof of the completion of irrigation works and of the use of water is to be submitted, and if the work has been done in accordance with the permit a certificate or license is issued that states the nature and extent of the rights acquired. The land irrigated in 1919 under rights of this character is 16.9 per cent of the total area irrigated.

Since so large a part of the rights have been acquired in a manner in which they are not defined as acquired, the states have made provision for defining rights. The nature of the procedure adopted and the date of its adoption in the several states are shown on page 48. In all of the states except Nebraska and Wyoming, rights are defined in the courts, and 37.3 per cent of all the land irrigated in 1919 was supplied with water

under rights that have been defined by courts. As shown on page 48, in Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, and South Dakota, rights are defined by the courts on the testimony of interested parties without the aid of state officials or boards; while Arizona, California, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Utah, and Washington provide for the making of surveys, the collection of information, and the formulation of decrees by state boards or officials, with provision for review and the issuing of decrees defining rights by the courts. The returns do not show what part of the rights that have been defined by the courts have been defined by each of these procedures.

Table 33, which follows, shows the percentages of the areas irrigated in each of the states, in 1919, that are served by rights of the various classes.

TABLE 33.—PERCENTAGE OF ACREAGE IRRIGATED IN 1919, SERVED BY WATER RIGHTS OF VARIOUS CLASSES.

STATE.	Ap- pro- priation and use.	No- tice filed and posted.	Ad- judi- cated by court.	Per- mit from state.	Certi- ficate license from state.	Ri- parian rights.	Under- ground.	Other, mixed, and not-re- ported.
Total.....	13.1	14.4	37.3	10.2	6.7	1.9	5.6	10.7
Arizona.....	48.5	29.8	18.2	(1)			5.9	3.6
Arkansas.....								100.0
California.....	11.4	16.7	23.3	1.9	0.6	5.7	20.5	20.0
Colorado.....	3.4	6.2	87.2				0.4	2.9
Idaho.....	5.3	9.6	44.4	19.6	13.6	0.6	0.1	6.9
Kansas.....	53.9	8.9	0.9				28.5	5.7
Louisiana.....								100.0
Montana.....	13.7	39.6	41.7			0.3	(1)	4.6
Nebraska.....	9.5	3.7	2.1	53.0	26.6	0.1	0.1	4.7
Nevada.....	35.7	9.3	28.7	19.0	1.2		0.2	5.9
New Mexico.....	28.4	10.1	17.1	19.2	3.7	0.1	9.7	11.7
North Dakota.....	52.6	19.3		24.3				3.8
Oklahoma.....	1.2	7.2	74.1	10.4		2.7	4.0	0.3
Oregon.....	15.1	15.3	29.8	13.3	22.0	1.5	0.3	2.7
South Dakota.....	1.8	61.6	7.6	17.4	8.6	1.6	0.1	1.4
Texas.....	11.8	17.9	0.5	39.2	2.0	12.4	7.6	8.6
Utah.....	34.4	12.5	42.4	4.1	4.9		0.6	1.2
Washington.....	37.1	32.0	10.6	7.5	3.3	3.2	3.9	2.3
Wyoming.....	2.1	5.0	13.4	38.6	37.8		(1)	3.0

¹ Less than one-tenth of 1 per cent.

In Table 34, the percentages of the areas irrigated in 1919 and 1909 that are served by rights that have

been defined or are being acquired under permits, so that they will be defined as they are acquired, are shown by states.

TABLE 34.—PERCENTAGE OF ACREAGE IRRIGATED IN 1919 AND 1909, THAT IS SUPPLIED BY WATER UNDER DEFINED RIGHTS.

STATE.	1919	1909
Total.....	54.2	47.7
Arizona.....	18.2	8.6
California.....	25.8	28.0
Colorado.....	87.2	84.4
Idaho.....	77.6	55.6
Kansas.....	0.9	(1)
Montana.....	41.7	38.0
Nebraska.....	81.7	81.1
Nevada.....	48.0	7.6
New Mexico.....	40.0	13.7
North Dakota.....	24.3	4.3
Oklahoma.....	65.1	17.1
Oregon.....	65.1	9.2
South Dakota.....	33.6	39.7
Texas.....	41.7	(1)
Utah.....	51.4	42.2
Washington.....	21.4	7.6
Wyoming.....	89.9	90.5

¹ Less than one-tenth of 1 per cent.

The degree to which rights have been defined in the several states seems to depend more largely upon the time when they adopted plans for defining rights than upon the character of the system adopted. Colorado was the first state to adopt a special procedure in the courts for this purpose and reports that more than 87 per cent of the land irrigated in the state is served by defined rights. Wyoming was the first state to provide for the defining of rights by an administrative board and shows about 90 per cent of the land served by defined rights—the highest percentage shown by any state, while Nebraska, the only other state having this system, ranks high.

The table shows a slight advance in the area served by defined rights in the states taken as a whole, with very marked increases in Nevada, New Mexico, Oklahoma, Oregon, and Texas, and slight decreases in several of the states. In most cases the decreases are due to the new enterprises, the rights for which have not been defined.

PUMPING FOR IRRIGATION.

The summary for the United States and the reports for the several states contain data on the areas irrigated with pumped water and on pumping equipment. This chapter contains additional information regarding pumping equipment, and brings together that found in the other reports, in order to make a complete presentation of the data relating to pumping for irrigation collected in the Fourteenth Census, with such comparisons with the results of the Thirteenth Census as can be made.

Table 35 shows the areas receiving either a total or a partial water supply from pumps in 1919, by states. In classifying the areas irrigated in 1909 by the source of supply all areas were credited to what seemed to

be the principal source of supply, so that comparisons of the areas receiving pumped water in 1919 and in 1909 are not justified.

Other tables follow, without discussion. The accuracy of the data is discussed on pages 9 to 11.

The average investment per acre in 1910 for pumping enterprises furnishing the entire water supply to the land irrigated was \$21.96 per acre, while that reported for 1920 was \$85.92, an increase of 62.8 per cent. The per cent of increase from 1910 to 1920 in average investment per acre for all classes of enterprises was 69.1 per cent, showing that the pumping enterprises increased in about the same proportion as did all others.

IRRIGATION.

TABLE 35.—DISTRIBUTION OF AREA IRRIGATED WITH PUMPED WATER IN 1919, BY STATES.

STATE.	TOTAL SUPPLY PUMPED.							PARTIAL SUPPLY PUMPED.								
	Total.		Streams.		Wells.		Lakes.	Total.		Streams, gravity, and pumped.		Streams, gravity, and pumped wells.		Wells, flowing and pumped.		
	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total.	Acres.	Per cent of total.		
Total	2,525,338	100.0	1,226,510	100.0	1,263,098	100.0	35,730	100.0	579,993	100.0	199,595	100.0	344,713	100.0	35,685	100.0
Arizona.....	46,370	1.8	6,671	0.5	39,694	3.1	5	(1)	218,357	37.6	.....	.....	217,799	63.2	558	1.6
Arkansas.....	141,719	5.6	6,099	0.5	135,260	10.7	450	1.3	250	(1)	.....	.....	250	0.1	.....	.....
California.....	1,126,687	44.6	295,673	24.1	826,846	65.5	4,168	11.7	171,736	29.6	69,278	30.2	87,897	25.5	23,561	66.0
Colorado.....	23,732	0.9	12,747	1.0	10,114	0.8	871	2.4	25,773	4.4	9,430	4.7	16,258	4.7	85	0.2
Idaho.....	112,507	4.5	107,181	8.7	414	(1)	4,912	13.7	2,227	0.4	1,870	0.9	357	0.1	.....	.....
Kansas.....	13,965	0.6	730	0.1	13,235	1.0	.....	.....	2,190	0.4	600	0.3	1,540	0.4	50	0.1
Louisiana.....	409,576	16.2	248,306	20.2	154,304	12.2	8,966	19.5	23,740	4.1	12,620	6.3	10,045	2.9	1,075	3.0
Montana.....	15,961	0.6	15,743	1.3	139	(1)	79	0.2	20,027	3.5	19,872	10.0	155	(1)	.....	.....
Nebraska.....	1,661	0.1	1,115	0.1	546	(1)	.....	.....	965	0.2	850	0.4	115	(1)	.....	.....
Nevada.....	2,942	0.1	2,647	0.2	295	(1)	.....	.....	5,742	1.0	720	0.4	4,957	1.4	65	0.2
New Mexico.....	17,599	0.7	1,890	0.2	15,709	1.2	.....	.....	7,897	1.4	.....	.....	1,341	0.4	6,556	18.4
North Dakota.....	2,469	0.1	2,469	0.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oklahoma.....	295	(1)	188	(1)	107	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oregon.....	68,189	2.7	64,576	5.3	1,993	0.2	1,620	4.5	698	0.1	253	0.1	105	(1)	340	0.1
South Dakota.....	869	(1)	869	0.1	.....	.....	.....	.....	500	0.1	.....	.....	500	0.1	.....	.....
Texas.....	461,618	18.3	421,538	34.4	39,483	2.1	597	1.7	2,531	0.4	350	0.2	454	0.1	1,727	4.8
Utah.....	29,097	1.2	10,389	0.8	7,508	0.6	11,400	31.9	353	0.1	50	(1)	125	(1)	178	0.5
Washington.....	48,410	1.9	26,244	2.1	17,504	1.4	4,662	13.0	96,607	16.7	92,792	46.4	2,415	0.7	1,490	4.2
Wyoming.....	1,672	0.1	1,525	0.1	147	(1)	.....	.....	400	0.1	.....	.....	400	0.1	.....	.....

(1) Less than one-tenth of 1 per cent.

TABLE 36.—DISTRIBUTION OF PUMPING EQUIPMENT, 1920 AND 1910, BY STATES.

STATE.	PUMPING PLANTS.						PUMPS.			Average lift, 1920 (feet). ²	
	Number.		Per cent of increase. ¹	Engine capacity (horsepower).			Number, 1920. ³	Capacity (gallons per minute).			
	1920	1910		1920	1910	Per cent of increase. ¹		1920	1910		Per cent of increase. ¹
Total	29,458	15,863	88.4	748,971	361,480	107.2	33,804	36,275,005	19,355,864	87.4	41
Arizona.....	744	429	73.4	22,014	37,258	-40.9	1,001	1,948,030	851,873	23.6	44
Arkansas.....	1,041	315	230.5	58,332	12,440	368.9	1,121	1,654,097	436,402	279.0	50
California.....	21,541	9,297	131.9	386,260	128,143	201.4	24,134	16,773,692	5,276,298	217.9	41
Colorado.....	406	206	97.1	8,635	7,369	8.4	435	290,726	246,937	0.9	23
Idaho.....	143	58	146.6	28,364	7,065	301.5	232	1,397,681	278,569	401.7	29
Kansas.....	198	698	-71.6	6,946	1,517	357.9	288	297,975	128,276	132.3	30
Louisiana.....	1,250	1,007	24.1	85,628	57,426	49.1	1,941	4,968,686	5,064,173	-1.9	32
Montana.....	253	125	102.4	10,341	3,511	194.5	239	433,231	281,199	61.2	20
Nebraska.....	51	75	-32.0	959	140	587.0	54	73,686	5,396	.....	24
Nevada.....	64	18	255.6	409	693	-41.0	72	35,266	24,295	45.2	22
New Mexico.....	472	413	14.3	8,488	14,226	-40.3	491	304,789	216,355	40.9	40
North Dakota.....	4	4	.....	2,068	2,038	1.5	10	51,250	182,135	-71.9	38
Oklahoma.....	22	68	-67.6	184	167	72.0	26	7,668	4,541	68.9	39
Oregon.....	573	229	150.2	13,769	3,065	344.9	614	600,045	118,514	406.3	28
South Dakota.....	25	8	212.5	498	63	630.5	25	29,320	5,280	340.9	51
Texas.....	1,369	2,359	-42.0	80,511	69,094	16.5	1,641	6,825,998	5,362,605	27.3	45
Utah.....	250	69	262.3	11,392	2,143	431.6	291	783,588	315,057	148.7	25
Washington.....	975	391	149.4	22,929	13,847	65.6	1,059	630,552	365,411	74.2	60
Wyoming.....	57	34	67.6	1,304	705	85.0	70	39,725	142,529	-72.1	31

¹ A minus sign (-) denotes decrease. Per cent not shown when more than 1,000.

² Not reported in 1910.

TABLE 37.—DISTRIBUTION OF CAPITAL INVESTED, 1920, AND COST OF OPERATION AND MAINTENANCE, 1919, FOR ENTERPRISES USING PUMPED WATER, BY SOURCE OF WATER SUPPLY.

SOURCE.	CAPITAL INVESTED, 1920.				COST OF OPERATION AND MAINTENANCE, 1919.			
	Amount.	Per cent of total.	Average per acre.		Area for which cost is reported (acres).	Amount.	Per cent of general average.	
			Amount.	Per cent of general average.				
Total supply pumped	138,274,470	100.0	138.27	47.0	2,201,209	8.15	335.4	
Streams.....	59,343,298	42.9	59.34	27.3	1,151,313	6.50	287.5	
Wells.....	76,787,951	55.5	76.79	35.3	1,064,338	10.07	414.4	
Lakes.....	2,274,601	1.6	2.27	1.0	45,558	5.20	214.0	
Partial supply pumped	40,244,986	100.0	40.24	9.86	543,896	4.75	195.5	
Streams, gravity and pumped.....	9,406,594	23.6	9.41	5.94	198,656	2.33	85.9	
Wells, flowing and pumped.....	29,838,392	74.2	29.84	11.4	29,600	8.04	330.9	
Streams, gravity, and pumped wells.....	28,347,835	70.7	28.35	9.86	315,640	5.97	215.7	

133.5

104.3

176.1

141.1

224.0

147.6

218.1

271.2

60.05

TABLE 38.—DISTRIBUTION OF PUMPED WELLS, BY DATE OF BEGINNING.

DATE OF BEGINNING	Number	Per cent of total	CAPACITY GALLONS PER MINUTE	
			Amount	Per cent of total
Total	22,094	100.0	16,386,549	100.0
Before 1880	37	0.1	19,428	0.1
1880-1889	79	0.2	28,980	0.2
1890-1899	82	0.3	46,174	0.3
1900-1909	327	1.0	144,829	0.9
1910-1919	948	2.6	490,323	2.4
1920-1924	1,591	5.0	745,045	4.5
1925-1929	4,304	19.3	1,741,380	10.6
1930-1934	19,497	88.2	5,436,719	33.2
1935-1939	10,971	49.7	5,961,601	35.7
Not reported	4,280	19.7	1,962,562	12.0

TABLE 39.—DISTRIBUTION OF PUMPING EQUIPMENT, BY DATE OF BEGINNING.

DATE OF BEGINNING	PUMPING PLANTS		ENGINE CAPACITY (HORSEPOWER)		PUMPS			
	Number	Per cent of total	Number	Per cent of total	Number		Capacity (gallons per minute)	
					Amount	Per cent of total	Amount	Per cent of total
Total	29,458	100.0	748,971	100.0	33,804	100.0	36,275,005	100.0
Before 1880	48	0.1	664	0.1	55	0.2	28,092	0.1
1880-1889	43	0.1	574	0.1	44	0.1	43,436	0.1
1890-1899	89	0.3	3,627	0.5	108	0.3	86,237	0.2
1900-1909	390	1.0	14,258	2.0	497	1.2	1,476,539	4.1
1910-1919	668	2.3	37,387	5.0	862	2.5	4,278,623	12.1
1920-1924	1,435	4.9	99,286	13.2	1,741	5.2	3,796,532	10.2
1925-1929	2,994	9.9	98,729	13.2	3,492	10.3	4,270,561	12.1
1930-1934	9,464	32.1	326,748	43.6	19,867	58.1	8,318,711	22.9
1935-1939	10,469	35.5	342,429	45.7	11,713	34.6	10,669,654	29.4
Not reported	4,038	12.7	84,399	11.3	4,313	13.4	3,135,635	8.9

TABLE 40.—DISTRIBUTION OF PUMPED WELLS, BY TYPE OF ENTERPRISE.

CLASS	NUMBER		CAPACITY (GALLONS PER MINUTE)	
	Amount	Per cent of total	Amount	Per cent of total
Total	22,094	100.0	16,386,549	100.0
Individual and partnership	26,415	94.8	14,333,278	87.5
Cooperative	1,682	7.6	1,614,128	9.8
Irrigation district	109	0.5	93,779	0.6
Commercial	298	1.3	228,279	1.4
U. S. Reclamation Service	49	0.2	46,000	0.3
U. S. Indian Service	72	0.3	7,368	0.04
State	24	0.1	3,636	0.02
City	32	0.1	27,619	0.2
Other	13	(1)	9,570	0.1

¹ Less than one-tenth of 1 per cent.

Efficiency of pumping plants.—The census returns on pumping are not sufficiently accurate to justify the computation of the efficiency of pumping plants. In many instances the schedules contained only a part of the information required, and it was not possible to supply what was lacking. However, a special tabulation was made from the schedules that contained engine capacity, pump capacity and average lift, and the results are given in Tables 45 and 46, with the ratio between engine capacity and the work done, computed on the pump capacity and the average lift.

TABLE 41.—DISTRIBUTION OF PUMPING EQUIPMENT, BY TYPE OF ENTERPRISE.

CLASS	PUMPING PLANTS		ENGINE CAPACITY (HORSEPOWER)		PUMPS			
	Number	Per cent of total	Number	Per cent of total	Number		Capacity (gallons per minute)	
					Amount	Per cent of total	Amount	Per cent of total
Total	29,458	100.0	748,971	100.0	33,804	100.0	36,275,005	100.0
Individual and partnership	28,336	96.2	637,361	71.6	31,564	93.4	22,563,649	62.2
Cooperative	732	2.6	82,963	11.1	1,252	3.7	3,515,742	9.7
Irrigation district	109	0.3	43,394	5.8	312	0.9	1,837,264	5.1
City Act	(1)	(1)	746	0.1	25	0.1	—	—
Commercial	188	0.6	66,469	8.9	464	1.4	6,814,220	18.8
U. S. Reclamation Service	13	0.1	14,423	1.9	84	0.2	978,170	2.7
U. S. Indian Service	14	(1)	733	0.1	25	0.1	87,248	0.2
State	26	0.1	416	0.1	21	0.1	60,810	0.2
City	18	0.1	2,225	0.3	40	0.1	411,722	1.1
Other	15	0.1	281	(1)	17	0.1	11,185	(1)

¹ Less than one-tenth of 1 per cent.

TABLE 42.—DISTRIBUTION OF PUMPING EQUIPMENT, BY KIND OF PUMP.

KIND OF PUMP	CAPACITY OF ENGINES (HORSEPOWER)		NUMBER OF PUMPS		CAPACITY OF PUMPS (GALLONS PER MINUTE)		Average lift (feet)
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	
Centrifugal	581,274	77.6	25,419	77.0	29,260,062	80.6	33
Rotary	26,716	4.9	1,305	3.9	2,089,211	5.8	42
Reciprocating	23,344	4.3	3,729	8.1	735,362	2.0	94
Turbine	24,390	3.3	677	2.0	525,728	1.4	84
Air lift	16,672	1.3	319	0.9	304,165	0.8	53
Other, mixed, and not reported	64,175	8.6	2,785	8.1	3,370,537	9.3	57

TABLE 43.—DISTRIBUTION OF PUMPING EQUIPMENT, BY KIND OF POWER.

KIND OF POWER	CAPACITY OF ENGINES (HORSEPOWER)		NUMBER OF PUMPS		CAPACITY OF PUMPS (GALLONS PER MINUTE)		Average lift (feet)
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	
Wind	10,768	1.4	287	0.8	247,445	0.7	44
Water	8,043	1.1	166	0.5	212,346	0.6	40
Steam	106,568	14.2	1,832	5.5	7,526,435	20.7	26
Electricity	289,018	38.6	12,743	37.7	13,811,435	38.7	50
Gas	259,613	34.7	18,691	46.4	10,461,857	28.8	35
Other, mixed, and not reported	74,611	10.0	3,055	9.0	4,515,487	12.4	46

TABLE 44.—COMPARISON OF CAPACITY OF ENGINES AND CAPACITY OF PUMPS, 1920 AND 1910, BY KIND OF POWER.

KIND OF POWER	CAPACITY OF ENGINES (HORSEPOWER)			CAPACITY OF PUMPS (GALLONS PER MINUTE)		
	1920	1910	Per cent of increase ¹	1920	1910	Per cent of increase ¹
Total	671,691	361,480	85.8	32,333,097	19,255,864	67.0
Wind	10,653	1,525	600.5	226,020	71,403	216.6
Water	4,890	17,623	-71.7	154,432	603,606	-74.4
Steam	91,124	149,177	-39.0	6,387,040	11,068,697	-42.3
Electricity	287,268	81,536	399.0	11,895,079	1,898,372	511.2
Gas	227,316	123,209	92.6	9,632,395	4,782,800	102.2
Other, mixed, and not reported	70,313	27,387	156.7	4,330,122	950,966	355.3

¹ A minus sign (-) denotes decrease.

TABLE 45.—RATIO OF ENGINE CAPACITY TO WORK DONE, BY KIND OF PUMP.

[Work done computed on pump capacity and average lift.]

KIND OF PUMP.	Capacity of engines (horse-power).	Capacity of pumps (gallons per minute).	Average lift (feet).	Ratio of engine capacity to work done.
Total.....	671,694	32,333,097	40	48.6
Centrifugal.....	519,535	26,257,469	33	42.1
Rotary.....	31,869	1,528,093	45	54.5
Reciprocating.....	29,745	620,995	97	61.1
Turbines.....	22,756	478,996	81	43.0
Air lift.....	9,736	297,798	60	46.4
Other, mixed, and not reported.....	58,301	3,150,064	49	6.7

TABLE 46.—RATIO OF ENGINE CAPACITY TO WORK DONE BY KIND OF POWER.

[Work done computed on pump capacity and average lift.]

KIND OF POWER.	Capacity of engines (horse-power).	Capacity of pumps (gallons per minute).	Average lift (feet).	Ratio of engine capacity to work done.
Total.....	671,694	32,333,097	40	48.6
Wind.....	10,683	226,029	40	21.4
Water.....	4,990	154,422	43	33.6
Steam.....	91,124	6,387,040	38	67.2
Electricity.....	257,268	11,603,679	49	55.8
Gas.....	237,316	9,632,395	34	34.8
Other, mixed, and not reported.....	70,313	4,330,122	46	71.5

LAND IN IRRIGATION ENTERPRISES REPORTED AS AVAILABLE FOR SETTLEMENT.

An important factor in determining the need for the construction of additional irrigation works is the area of land available for settlement under existing enterprises. The reports of areas irrigated in 1919 and areas enterprises were capable of irrigating in 1920 indicate a very large area already supplied with water that is not in use (see p. 19). While this land is not in use and is available for expansion of the irrigated area, it is not, necessarily, available for settlement. As a check on these figures, and for the purpose of determining how much land in existing irrigation enterprises was actually available for settlement, its location, and the terms on which it can be obtained, inquiries covering these points were placed on the irrigation schedules.

The instructions to enumerators showing what should be reported under these inquiries were as follows:

Land available for settlement covered by this enterprise.—This item should be limited to land for which water is available or is to be made available, and which is not yet settled. Land already settled should not be included even if it is for sale, unless the holdings are to be subdivided, when only the parts of such holdings that are to be sold for new farms should be reported as available for settlement. If the management of an enterprise is itself farming land pending its settlement, the land should be reported as available for settlement.

Price of unimproved lands suitable for agriculture covered by this enterprise.—This item relates strictly to land covered by the enterprise reported, and not to other land in the vicinity. If no unimproved land is included in the enterprise this inquiry should

not be answered. If land and water rights are sold together for a specified price and it is not possible to segregate the part representing land from that representing water rights, this fact should be stated and the part representing land should be estimated. If land is not for sale at a uniform price, the average price prevailing at the time of the canvass should be given.

Average cost of preparing land for irrigation.—Under this heading should be given the best estimate obtainable from the officials of the enterprise reported or from farmers operating under the enterprise. Frequently this amount will vary so much from farm to farm that a strictly accurate reply to this inquiry can not be obtained; yet for any enterprise it should be possible to make a fairly representative estimate.

In State Table II, on page 94, the land reported as available for settlement is given by counties, with such information as the schedules contained, as to the types of enterprises supplying water, sources of water supply, prices of land and water rights, terms on which land and water rights are sold, and the cost of preparing land for irrigation. Prices and cost vary so much that no attempt has been made to average them.

IRRIGATED CROPS.

The areas, production, and values of the principal crops grown on irrigated land are given in the State Reports and in the United States Summary, which are contained in this volume. In none of these reports however, is shown the distribution of the crops by counties. There has been considerable call for this information, and it is presented in State Table I, beginning on page 71.

As stated in the discussion of the accuracy of the results of the census of irrigation, the returns for crops grown under irrigation are not considered complete. Enumerators were instructed to mark on the farm schedules the crops that were irrigated, and in many instances it was evident that this instruction was not followed. Where this was the case, the crops were marked as irrigated, but there were many cases where there was doubt as to whether crops were irrigated, and in such cases they were not marked. Consequently, the figures given should be considered as below the correct figures. For a few counties, however, the total area of crops reported as irrigated exceeds the total area of land reported as irrigated. The two items are taken from different schedules and each has been tabulated as reported. This course seemed better than to adjust the figures arbitrarily.

Owing to the fact that the reports of the census of agriculture give complete crop returns by counties, only the areas harvested are reported here.

The totals for the areas harvested, production, and value for each crop, by states, are included in the table. Average yields per acre are given in the state reports and can be computed from the figures reported here.

The values are computed in the manner stated on page 14. Averages per acre can be computed from the figures given here.