PART I

GENERAL DISCUSSION

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AREA IRRIGATED

The total area reported as irrigated in the United States in 1929, exclusive of small areas of truck and fruit crops in the Eastern States not included in the census of irrigation, is 19,547,544 acres, an increase of 355,828 acres, or 1.9 per cent, over the area irrigated in 1919. This is a much smaller increase than that during the preceding decade (4,758,431 acres), but marks a continuation of the trend then shown, the 1909–1919 increase having been somewhat smaller than that characterizing the 1899–1909 decade (6,688,818 acres).

In addition to the changes in the general economic conditions of agriculture occurring between 1919 and 1929, which served to delay development in many sections, other circumstances also had an influence on the extent of irrigation in 1929.

CLIMATIC CONDITIONS AFFECTING EXTENT OF IRRIGATION

Climatic conditions in both 1929 and 1919 were unusual in many sections, being characterized especially by abnormally low precipitation. The average shortage was somewhat greater in 1929 than in 1919 in most of, though not all of, the Mountain and Pacific States. This shortage not only reduced the yields of crops grown without irrigation but also curtailed the supply of water available for irrigation. Some valleys protected by storage reservoirs of large capacity were not affected by the general shortage, as the run-off from their drainage basins, though below normal, was sufficient to fill them; but other sections dependent upon direct stream flow reported considerable curtailment of the areas normally irrigated, especially those holding water rights of late priority. Still other valleys, where the deficiency of precipitation and consequent run-off was most severe, were able to report irrigated areas equal to, or even greater than, those previously reported, principally by reason of the recent very considerable development of pumping from wells which had been stimulated partly by preceding seasons of drought.

The severity of the 1929 drought is brought out by Table 1, which was compiled from the records of the United States Weather Bureau. The table includes only the States in the Mountain and Pacific divisions because precipitation had small and localized influence on the extent of irrigation in the other irrigation States.

TABLE 1.—PRECIPITATION FOR THE YEARS 1929 AND 1919, AND ITS DEPARTURE FROM AND PROPORTION OF THE NORMAL, 1929, IN THE MOUNTAIN AND PACIFIC STATES

STATE	Average for the State, 1929	Departure from normal,[1] 1929	Proportion of normal, 1929	Average for the State, 1919
MOUNTAIN DIVISION	*Inches*	*Inches*	*Per cent*	*Inches*
Montana	13.08	−2.36	84.7	11.14
Idaho	13.06	−4.04	76.4	16.44
Wyoming	15.06	+0.58	104.0	10.46
Colorado	18.16	+0.96	105.6	17.26
New Mexico	16.48	+1.62	110.9	20.96
Arizona	11.14	−2.65	80.8	19.19
Utah	13.60	−0.10	99.3	11.83
Nevada	5.83	−2.35	71.3	7.08
PACIFIC DIVISION				
Washington	23.67	−12.44	65.5	31.00
Oregon	22.79	−7.78	74.6	31.07
California	15.00	−10.52	58.8	21.29

[1] A plus sign (+) denotes excess. A minus sign (−) denotes deficiency.

Figure 1 (p. 14) illustrates the facts brought out by Table 1. East of the Rocky Mountains the year 1929 was somewhat cooler and wetter than normal in most sections, while west of the Rocky Mountains these conditions were reversed. Precipitation was generally above normal in central and southern States from the Rocky Mountains eastward, though it was deficient in parts of the Southwest; in northern States it was mostly below normal. West of the Rocky Mountains precipitation was decidedly deficient practically everywhere. For the United States as a whole the greatest plus departures from the normal occurred in the interior of the Southeast and in some Rocky Mountain sections, with the greatest deficiencies in the Pacific Coast area where some sections had less than half the normal amount of rainfall for the year.

The following paragraphs summarize the 1929 weather conditions in the several States included in the census of irrigation:

MOUNTAIN DIVISION

Montana.—While a record-breaking cold winter was succeeded by an exceptionally mild March, the following three months were unseasonably cool. The summer was hot and the third driest on record. These arid conditions caused an early drying up of pastures, ranges, and water holes, as well as a serious deterioration of all vegetation, which cut materially the yields of most staple crops.

The mean annual temperature for the State (40.9°) was 1.4° below normal. The average annual precipitation (13.08 inches) was 2.36 inches below normal.

Precipitation for the last three months of 1928 was 2 inches, which was 0.80 inch below normal.

Idaho.—The year was the coldest since 1922, with mean temperatures below normal throughout the State except in a few localities in the Upper Salmon River Valley and the Lost River and Swan Valleys. Precipitation was the least of any year of record except 1924. As the preceding year also was unusually dry, the combined precipitation for 1928 and 1929 was less by far than that of any other two consecutive years of record. Deficiencies were most pronounced in February and May, and from July through November. The drought, which began the last week in June, was not broken in most localities until the second week in December, except for occasional light showers, the moisture from which evaporated shortly after falling. Irrigated crops grew well except in localities where water was short.

Precipitation for the last three months of 1928 was 4.29 inches, which was 1.40 inches below normal.

Wyoming.—The year was cooler and somewhat wetter than normal. Mean annual temperature was 1.5° below normal. January, February, and November were abnormally cold; August and December were abnormally warm; temperatures of other months were nearly normal.

Precipitation for the year was about 90 per cent of normal in Yellowstone National Park and in Teton, Lincoln, Uinta, Sublette, Washakie, Park, and Laramie Counties and the Wind River Valley of Fremont County; but elsewhere it was greater than normal. In March, April, and the first week of May precipitation was 150 per cent of normal, but the remainder of May, June, July, and August received only 81 per cent of their usual rainfall. The growing season was closed in most parts of the State about 10 days earlier than usual by the cold spell of September fifth to eighth.

Precipitation for 1928 was only 0.01 inch below normal.

Colorado.—Mean annual temperature was 1.3° below normal, but June, July, and August were warmer than normal.

Generally droughty conditions characterizing April, May, and June, were relieved by rains averaging 1 inch in excess of normal for the State, in July, August, and September. Weather stations representing about two-thirds of the State's area reported precipitation above normal for the year, and August and

September were the third wettest similar months of record. The total mean annual precipitation (18.16 inches) was about 1 inch in excess of normal.

On the eastern slope and in San Luis Valley the water supply was subnormal, especially during the early part of the growing season. This condition was due either to deficient snowfall in the mountains or to low temperatures during the spring months. Carry-over storage from 1928, together with copious rainfall beginning in July, furnished abundant water for the latter part of the growing season. The water supply on the western slope was generally above normal. The State's 1928 precipitation was only 0.22 inch below normal.

New Mexico.—Mean annual temperature was 1.1° below normal, all parts of the State sharing in the deficiency, which characterized all months of the year except April, June, and December.

Mean annual precipitation for the State (16.48 inches) was 1.62 inches above normal, the excess being fairly general throughout the State, although greatest near the northern border and in the central and northern mountain areas. Pecos Valley experienced a deficiency. August was the wettest month of the year, the rainfall averaging 3.57 inches.

Precipitation for 1928 was 0.14 inch above normal.

Arizona.—The mean annual temperature (61.3°) was 0.5° lower than normal. May, October, and December temperatures were well above normal, while February and November were cool.

Average annual precipitation (11.14 inches) was 2.65 inches below normal, but 1.47 inches above the 1928 average. July, August, and September rainfall records were each about one-half inch above normal, but March, November, and December were unusually dry. Rainfall in western, northern, and central Arizona was decidedly below the average. Precipitation was generally deficient from November, 1928, to July, 1929. The soil was unusually dry, and absorbed most of the melted snows in spring and a large proportion of the run-off from the late summer rains.

Utah.—The mean annual temperature (47.5°) was 0.7° less than normal. July, August, October, and December were warmer than usual in most sections of the State, but the other months were colder.

Average annual precipitation (13.60 inches) was only 0.10 inch below normal, wet weather generally characterizing the spring season. May was drier than usual, but the summer months also were wet, although the precipitation was unevenly distributed, some sections experiencing severe deficiencies, while in others the rainfall was excessive.

Precipitation for the last three months of 1928 was 3.78 inches, which was 0.13 inch above normal.

Nevada.—The average temperature for the year was about normal. January, February, April, June, and November were abnormally cool, but July, August, October, and December were unusually warm.

Precipitation was deficient, averaging about two-thirds of the normal amount; 1929 was the fourth consecutive year with rainfall below normal. The two notable phenomena of the year were (1) the long hot spell which began about June 19 and ended about September 20, during which records for total number of days with temperature above 90° were broken at many recording stations, and some new records of high temperature were established, and (2) the drought which began about June 18 and continued with little relief in most parts of the State until December 9. Shortage of water for irrigation became acute in the latter part of August.

Precipitation for the last three months of 1928 was 1.50 inches, which was 0.81 inch below normal.

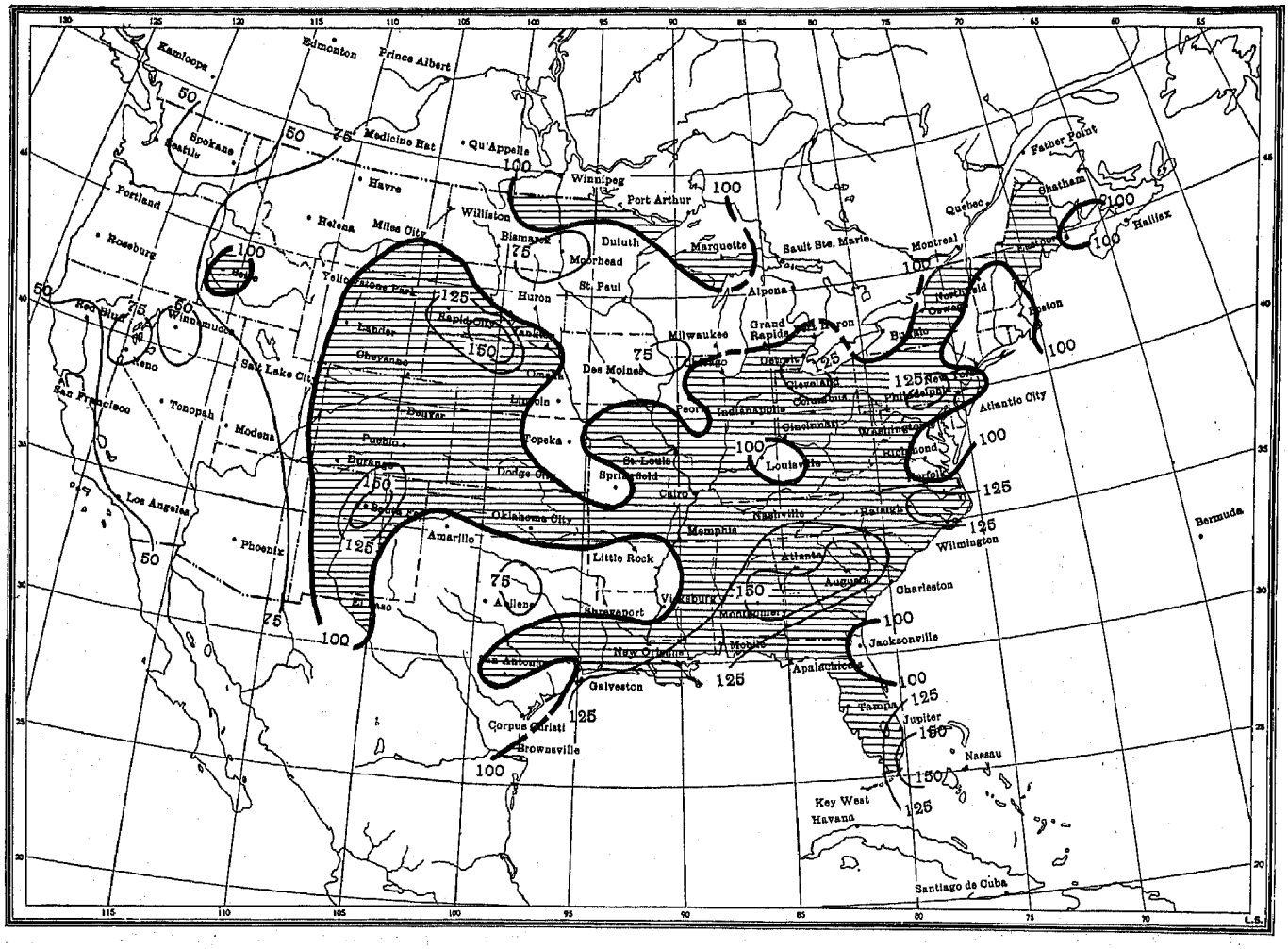


FIGURE 1.—PER CENT OF NORMAL PRECIPITATION FOR THE YEAR 1929

[Shaded portions show precipitation above normal; unshaded portions, below normal. Lines show percentages of normal. (After Chart II, Weekly Weather and Crop Bulletin, Series 1930, No. 2, Weather Bureau, U. S. Department of Agriculture.)]

Pacific Division

Washington.—The average temperature for the year (47°) was the second lowest of record, but the record-breaking low monthly averages for both January and February were largely responsible for the low average for the year, since temperatures of six of the other months averaged above normal.

The average annual precipitation was the lowest ever recorded, being only two-thirds the normal amount. At three-fourths of the recording stations the year was the driest of record; the deficiency was cumulative from the autumn of 1928 and reached its climax in the driest autumn of record in 1929, resulting in an acute condition which was state-wide.

Precipitation for the last three months of 1928 was 11.56 inches, which was 2.71 inches below normal.

Oregon.—Mean annual temperature (49°) was 0.7° below normal. Mean annual precipitation (22.79 inches) was 7.78 inches below normal, the year as a whole being the driest of record. For the counties west of the Cascades the average precipitation was 36.01 inches, a departure of −12.79 inches from their normal. For the eastern arid counties the precipitation was only 12.25 inches, a departure of −3.52 inches from their normal. The drought was prolonged and most severe throughout the summer and fall months. A similar drought characterized 1928, and was even more severe than the 1929 drought in the eastern counties.

California.—Mean annual temperature (57.7°) was nearly normal, but average annual precipitation was only about 59 per cent of normal, the deficiency characterizing all months except April, June, and December. Precipitation was poorly distributed, both as to time and amount.

Precipitation in 1928 was about 75 per cent of normal, being subnormal in every month except March and November. Snowfall in the mountains was much below the average.

Other States

North Dakota.—Mean annual temperature (38°) was 0.8° below normal. Average annual precipitation (14.32 inches) was 3.62 inches below normal. Total precipitation from September, 1928, to August, 1929, inclusive, was the lowest of record for like periods in the State's climatological history.

South Dakota.—The year, as a whole, was cold, although December and five of the spring and summer months reported average temperatures above normal. Average annual precipitation was somewhat in excess of normal, but rainfall during the crop-growing season was somewhat deficient.

Nebraska.—The year averaged colder and drier than normal, mean annual temperature (47.9°) being 0.8° below normal, and precipitation (23.09 inches) being 0.45 inch below normal. In the western and northwestern counties, however, precipitation was above normal, although of the growing months, May and August were marked by fairly general deficiencies.

Kansas.—For the State, the year was generally wet and cold; but while the temperature of the western counties averaged 1.4° less than normal, their annual precipitation was also slightly (0.13 inch) less than normal.

Oklahoma.—The year was slightly colder and wetter than normal for the State generally, but for the western counties the departure from the normal precipitation varied widely, deficiencies being marked in some sections and excesses equally marked in others. In these counties August was unusually dry, but the other growing months showed no uniform trend.

Arkansas.—Mean temperature for the year was slightly (0.7°) below normal, but for the crop season (April 1 to October 31) it was 0.3° above normal. Precipitation for the year was 1.62 inches below normal, and for the crop season it was 1.04 inches below normal.

Louisiana.—Mean annual temperature (67.2°) was normal. Mean annual precipitation (63.65 inches) was 8.32 inches above normal.

Texas.—Normal precipitation and slightly deficient temperature characterized the year as a whole. Mean annual temperatures were nearly normal in southwestern and coastal counties and only moderately or slightly deficient in the remainder of the State. The mean annual precipitation for the State was only 0.10 inch above normal, but departures from the normal by months and localities were wide.

Geographic distribution, by States.—The geographic distribution, by States, of the area irrigated in 1929 and 1919, and of the increase in the intervening decade, are shown in Table 2.

Table 2.—Area Irrigated and Increase, by States: 1929 and 1919

State	Land irrigated				Increase [1]	
	1929		1919			
	Area	Proportion of total	Area	Proportion of total	Area	Per cent
	Acres	*Per cent*	*Acres*	*Per cent*	*Acres*	
Total (19 States)	19,547,544	100.0	19,191,716	100.0	355,828	1.9
Arizona	575,590	2.9	467,565	2.4	108,025	23.1
Arkansas	151,787	0.8	143,946	0.8	7,841	5.4
California	4,746,632	24.3	4,219,040	22.0	527,592	12.5
Colorado	3,393,619	17.4	3,348,385	17.4	45,234	1.4
Idaho	2,181,250	11.1	2,488,806	13.0	−307,556	−12.4
Kansas	71,290	0.4	47,312	0.2	23,978	50.7
Louisiana	450,901	2.3	454,882	2.4	−3,981	−0.9
Montana	1,594,912	8.2	1,681,729	8.8	−86,817	−5.2
Nebraska	532,617	2.7	442,690	2.3	89,927	20.3
Nevada	486,648	2.5	561,447	2.9	−74,799	−13.3
New Mexico	527,033	2.7	538,377	2.8	−11,344	−2.1
North Dakota	9,392	(2)	12,072	0.1	−2,680	−22.2
Oklahoma	1,573	(2)	2,969	(2)	−1,396	−47.0
Oregon	898,713	4.6	986,162	5.1	−87,449	−8.9
South Dakota	67,107	0.3	100,682	0.5	−33,575	−33.3
Texas	798,917	4.1	586,120	3.1	212,797	36.3
Utah	1,324,125	6.8	1,371,651	7.1	−47,526	−3.5
Washington	499,283	2.5	529,899	2.8	−30,616	−5.8
Wyoming	1,236,155	6.3	1,207,982	6.3	28,173	2.3

[1] A minus sign (−) denotes decrease. [2] Less than one-tenth of 1 per cent.

In 1929 as in 1919, California showed the largest area irrigated, Colorado ranking second, Idaho third, Montana fourth, and Utah fifth. California led also in increase of area irrigated, but in this respect Texas was second, Arizona third, Nebraska fourth, and Colorado fifth. All the other States except Wyoming, Kansas, and Arkansas showed reductions.

Geographic distribution, by drainage basins.—The results of the census of 1930 have been tabulated by drainage basins, in conformity with the tabulations of the census of 1920. The distribution of area irrigated is shown in detail, in this way, in Table 8, page 51. The distribution by the principal drainage basins is summarized in Table 4, page 17.

In the following paragraphs the major basins are described briefly, and at their conclusion there is shown the relationship of the 1929 discharges of the principal streams to their normal annual discharges:

The northern half of the Great Plains, extending from the Rocky Mountains toward Mississippi River, is drained principally by Missouri River and its tributaries; a relatively small additional area in North Dakota is tributary to Hudson Bay through Souris and Red Rivers. In most of these areas some crops can be grown without irrigation, and the irrigated land is confined almost exclusively to the stream valleys. The Missouri itself and several of its tributaries are not largely utilized for irrigation. Storage has been provided for only a small part of the flood flow of the main stream and its tributaries north of the Platte River.

The North Platte River supplies extensive areas in Colorado, Wyoming, and Nebraska. Its low-water flow is largely utilized and storage has been provided for much of its flood water.

The South Platte River waters a large area in Colorado and a small area in Nebraska. Its low-water flow is fully utilized, and flood water and winter flow are stored in many small reservoirs.

The central part of the Great Plains is drained by Arkansas River and its tributaries. The Arkansas waters a large area in Colorado and a small area in Kansas. Its low-water flow is all used, and much of the flood water is stored in small reservoirs.

Practically all the land used for rice growing in Arkansas and a considerable part of that in Louisiana and Texas is watered from wells.

The rice grown along the Gulf coast in Louisiana and Texas is supplied principally by pumping from streams entering the

Gulf of Mexico. The supply of fresh water is limited unless storage is provided.

Streams flowing to the Gulf of Mexico supply scattered areas throughout central Texas; in northern Texas wells supply a considerable area.

The Rio Grande and its tributaries drain south central Colorado, most of central and eastern New Mexico, and the southwestern part of Texas. Large areas are irrigated in Colorado, considerable areas in New Mexico, and a large area in Texas. The Rio Grande is subject to heavy floods, but at times is dry or nearly so, and storage is necessary for permanently successful irrigation. There is little opportunity to use water from the Rio Grande below the El Paso Valley in Texas, except near the mouth of the river, where a large area is irrigated by pumping from the river.

The Pecos River, a tributary of the Rio Grande, drains much of southeastern New Mexico. It is subject to heavy floods and periods of very low discharge. Storage has been provided for a part of the flood flow. There are many flowing and pumped wells in the valley of the Pecos.

The Colorado River system drains nearly all the land west of the Rio Grande drainage area to the California boundary, and extends northward to northern Wyoming. It supplies water to land in Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona, and California. In the upper States the areas of tillable land in the valleys of the tributaries of the Colorado are limited and much of the low-water flow of these streams is not yet utilized, there being little storage. Near the mouth of the stream large areas are irrigated in Arizona and California. Gila River, which is a tributary of Colorado River, and its tributaries drain a considerable part of western New Mexico and most of southern Arizona. All these streams are subject to heavy floods and to periods of practically no discharge; consequently storage is necessary to make them reliable sources of water for irrigation.

Whitewater Draw receives the drainage of a small section of southern Arizona not tributary to Colorado River.

North and west of the Colorado River Basin is the Great Basin, which has no outlet to the sea. This basin includes small parts of Wyoming, Idaho, California, and Oregon, much of Utah, and most of Nevada. It consists of several independent drainage basins, one with the Great Salt Lake as its low point, another centering in the sinks of western Nevada, and a third consisting of the Sevier River drainage in southwestern Utah. There are also small basins in northern California and southern Oregon.

The Great Salt Lake receives almost its entire inflow from the mountains lying east of its basin, through streams which carry a large flow when the snow melts in the spring and a small flow during the summer. The low-water flow of all the streams in this drainage basin is used.

The sinks of western Nevada receive water from both east and west. Humboldt River and its tributaries drain most of the eastern slope of this basin. The Humboldt has a flood period in the spring and most of the irrigation along it consists in damming the stream so that it will overflow natural meadows on its bottom lands during its flood.

Walker, Carson, and Truckee Rivers flow into the sinks from California.

Throughout the Great Basin there are large valleys which have no surface water supply. In some of these a supply of ground water has been found.

North of the Great Basin and extending from western Montana and Wyoming to the Pacific Ocean is the Columbia River Drainage Basin. The Columbia and its tributaries water large areas in Montana, Idaho, Oregon, and Washington, but the Columbia itself is not extensively used for irrigation.

Clark Fork of the Columbia and its tributaries, the Bitter Root and Flathead Rivers, water lands in western Montana.

Snake River rises near the headwaters of the Missouri and Colorado in northwestern Wyoming and waters land in Idaho, Oregon, and Washington. Its low-water flow is all used, and storage has been provided for much of the flood water.

The tributaries of the Columbia coming from the Cascade Mountains in Washington supply water to most of the land irrigated in that State. Their low-water flow is used, and storage has been provided for a part of the flood water.

The tributaries of the Columbia in Oregon supply a large part of the irrigated land in that State, and could supply a much larger area.

West of the Cascade Mountains in Washington and Oregon there is an abundant supply of water and limited irrigation because of the heavy rainfall.

In northern California the dry season in summer is more pronounced than in Oregon and Washington, and at that time there is little water in the streams. Sacramento River waters a large area, and the summer flow is fully utilized.

The San Joaquin and its tributaries supply water to the larger part of the irrigated land in California. The low-water discharge of these streams is all used, and many wells and pumps in some sections furnish a supplemental supply of water when the streams are low, and in others provide the entire water supply.

The coastal streams south of San Francisco Bay are torrential in character. On some of them, reservoirs have been built to store flood waters, but on many others, reservoir sites do not exist and the main dependence of most irrigated valleys is pumped wells.

Run-off of typical western rivers in 1929, as related to their normal annual run-off, is shown in Table 3 which was compiled from records of the United States Geological Survey and other official sources. The 1929 measurements refer to records beginning with October, 1928, and ending with September, 1929, in conformity with the records of the other years entering into the computation of the normals. At the beginning of January in most parts of the United States much of the precipitation of the preceding three months is in storage in the form of snow or ice, or in ponds, lakes, and swamps, or as underground water, and this stored water passes off in the streams during the spring break-up. At the end of September, on the other hand, the only stored water available for run-off is possibly a small quantity in the ground; therefore, the run-off for the year beginning October 1 is practically all derived from precipitation within that year.

TABLE 3.—RUN-OFF OF TYPICAL WESTERN RIVERS AS RELATED TO THE NORMAL, 1929

RIVER	Gauging station	Approximate proportion of the normal
		Per cent
Arkansas	Canon City, Colo	101
Missouri	Fort Benton, Mont	94
North Platte	Saratoga, Wyo	113
South Platte	South Platte, Colo	85
Rio Grande	Del Norte, Colo	118
	San Marcial, N. Mex	103
	Eagle Pass, Tex	62
Colorado	Glenwood Springs, Colo	118
	Yuma, Ariz	107
Gila	Kelvin, Ariz	27
Great Basin streams—		
Bear	Collinston, Utah	62
Weber	Gateway, Utah	94
Truckee	Iceland, Calif	53
Humboldt	Palisade, Nev	38
Sevier	Gunnison, Utah	64
Columbia	The Dalles, Oreg	64
Yakima	Prosser, Wash	59
Snake	King Hill, Idaho	83
Clark Fork	Metaline Falls, Wash	71
Sacramento	Red Bluff, Calif	48
Pit	Big Bend, Calif	70
Feather	Oroville, Calif	44
American	Fairoaks, Calif	41
San Joaquin	Friant, Calif	52
Kern	Bakersfield, Calif	40
Kings	Piedra, Calif	74
Merced	Exchequer, Calif	62
Tuolumne	La Grange, Calif	59
Stanislaus	Knights Ferry, Calif	44

As shown in Table 4, page 17, irrigated lands drained by Pacific Ocean streams other than Colorado and Columbia Rivers were greatest in extent in 1929, displacing Missouri and Columbia Rivers, which had reported the largest acreages in 1919. This change was occasioned largely by extensive expansion of irrigated areas in Sacramento and San Joaquin Valleys of California.

Next to the Pacific Ocean streams, Rio Grande shows the largest increase, with Colorado River third and Missouri River fourth.

No lands under the Red River system were reported in 1919.

TABLE 4.—AREA IRRIGATED AND INCREASE, BY PRINCIPAL DRAINAGE BASINS: 1929 AND 1919

DRAINAGE BASIN	LAND IRRIGATED				INCREASE [1]	
	1929		1919			
	Area	Proportion of total	Area	Proportion of total	Area	Per cent
	Acres	*Per cent*	*Acres*	*Per cent*	*Acres*	
Total	19,547,544	100.0	19,191,716	100.0	355,828	1.9
Red River (of the North) tributaries	2,099	(2)			2,099	
Missouri River and tributaries	4,185,180	21.4	4,147,278	21.6	37,902	0.9
Mississippi River and tributaries, exclusive of Missouri River	902,560	4.6	958,493	5.0	−55,933	−5.8
Gulf streams other than Mississippi River and Rio Grande	662,958	3.4	698,077	3.6	−35,119	−5.0
Rio Grande and tributaries [3]	1,468,913	7.5	1,204,502	6.3	264,411	22.0
Independent streams in Rio Grande Drainage Basin	95,812	0.5	108,353	0.6	−12,541	−11.6
Colorado River and tributaries	2,537,124	13.0	2,312,047	12.0	225,077	9.7
Whitewater Draw and tributaries	3,301	(2)	5,871	(2)	−2,570	−43.8
Great Basin Drainage	2,069,986	10.6	2,313,163	12.0	−243,177	−10.5
Columbia River and tributaries	3,393,640	17.3	3,873,245	20.2	−479,605	−12.4
Pacific Ocean streams, other than Colorado and Columbia Rivers	4,225,971	21.6	3,570,687	18.6	655,284	18.4

[1] A minus sign (−) denotes decrease. Per cent not shown when more than 1,000.
[2] Less than one-tenth of 1 per cent.
[3] Not including "Independent streams in Rio Grande Drainage Basin."

Distribution, by character of enterprise.—The distribution of the area irrigated in 1929 and 1919, and of the increase in area irrigated, 1919 to 1929, shown in Table 5, displays 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 5.—AREA IRRIGATED AND INCREASE, BY CHARACTER OF ENTERPRISE: 1929 AND 1919

CHARACTER OF ENTERPRISE	LAND IRRIGATED				INCREASE [1]	
	1929		1919			
	Area	Proportion of total	Area	Proportion of total	Area	Per cent
	Acres	*Per cent*	*Acres*	*Per cent*	*Acres*	
Total	19,547,544	100.0	19,191,716	100.0	355,828	1.9
Individual and partnership	6,410,581	32.8	6,848,807	35.7	−438,226	−6.4
Cooperative	6,271,334	32.1	6,581,400	34.3	−310,066	−4.7
Irrigation district	3,452,275	17.7	1,822,887	9.5	1,629,388	89.4
Carey Act	86,772	0.4	523,929	2.7	−437,157	−83.4
Commercial	1,230,763	6.3	1,822,001	9.5	−591,238	−32.4
United States Bureau of Indian Affairs	331,840	1.7	284,551	1.5	47,289	16.6
United States Bureau of Reclamation	1,485,028	7.6	1,254,569	6.5	230,459	18.4
State	11,489	0.1	5,620	(2)	5,869	104.4
City	121,218	0.6	40,146	0.2	81,072	201.9
Other	146,244	0.7	7,236	(2)	139,008	
Not reported			570	(2)	−570	−100.0

[1] A minus sign (−) denotes decrease. Per cent not shown when more than 1,000.
[2] Less than one-tenth of 1 per cent.

Individual and partnership enterprises occupy in 1929, as in 1919, the first place, in extent of area supplied with water, although showing a reduction as compared with 1919, notwithstanding a very considerable increase in the number of individually owned pumping plants in many sections. The reduction is partly accounted for by the large increase in the area served by irrigation districts, many of which represent the consolidation of small enterprises of this and other classes.

The reduction of areas irrigated by cooperative enterprises is similarly accounted for. Despite the reduction in both these classes, combined they served nearly 65 per cent of the entire area irrigated in 1929. Cooperative enterprises showed a large increase in the decade 1909–1919, largely because of the taking over of enterprises begun under the Carey Act. The almost complete cessation of development, in recent years, under that law, and the marked activity in irrigation district development, together with the fact that the cooperative type of organization is not widely utilized for the development of new lands in large units, explain the falling off of areas classified as cooperative, during the decade 1919–1929.

The large increase in irrigation district areas did not change the status of the group as compared with the others, although the proportion of the total irrigated area which they represent rose from 9.5 per cent to 17.7 per cent; but the figures given in the table do not represent the full extent of the irrigation district movement, since the districts organized within United States Bureau of Reclamation enterprises are not included for reasons set out in the "Explanation of terms." Like cooperative enterprises, irrigation districts usually are not well adapted to the development of new lands, and the increase in area shown for them represents reorganizations of enterprises of other types more than new enterprises.

Commercial enterprises show a decline in area, because of many reorganizations which usually have had the effect of transferring them to the irrigation district or cooperative classification. A frequent arrangement offered to purchasers of land and water rights by enterprises of this type provides for the transfer to them of ownership of the irrigation system upon the payment of a specified proportion of the purchase price. Upon taking over such systems the farmers organize cooperative companies or irrigation districts to operate them.

United States Bureau of Reclamation enterprises retain the same relative status they had in 1919, but show the largest increase in area served of any group except irrigation districts, now having 7.6 per cent of the total as compared with 6.5 per cent in 1919. Because of their inclusion in enterprises of other classes, the area credited to the United States Bureau of Reclamation does not include certain lands not in Government projects, which obtain a part of their water from the United States Bureau of Reclamation under Warren Act or other water service contracts. Such areas increased from about 900,000 acres in 1919 to 1,234,230 acres in 1929. The increase in area shown for the United States Bureau of Reclamation in Table 5 therefore represents an actual extension of the irrigated area and not transfers from other classes.

The annual report of the Commissioner of the United States Bureau of Reclamation for the fiscal year ended June 30, 1930, shows the following distribution of areas not in Government projects, which were partly supplied in 1919 by Government works under Warren Act or other water-service contracts.

TABLE 6.—AREAS NOT IN GOVERNMENT PROJECTS BUT PARTLY SERVED BY GOVERNMENT WORKS, BY STATES, 1929

STATE	Irrigated area	Irrigable area
	Acres	*Acres*
Total	1,234,230	1,480,040
Arizona	67,800	90,280
Arizona-California [1]	210	230
Colorado	15,350	20,050
Idaho	820,570	932,670
Nebraska-Wyoming [2]	103,440	127,590
New Mexico-Texas [3]	60,000	71,000
Oregon	540	605
Oregon-California [4]	34,700	63,620
Utah	7,230	7,275
Washington	124,390	166,720

[1] Yuma project. [3] Rio Grande project.
[2] North Platte project. [4] Klamath project.

Since 1920, the United States Bureau of Reclamation has proceeded rapidly with the plan provided for in the reclamation act as follows:

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 carrying out this provision, the United States Bureau of Reclamation has transferred the operation of many projects and project units to water-users' associations and irrigation districts, although the Government still retains "title to and the management and operation of the reservoirs and the works necessary for their protection and operation." Table 7 (after a similar table in New Reclamation Era for June, 1930) shows the status of the completed projects or divisions constructed by the United States Bureau of Reclamation, the operation of which had been assumed in 1930 by the districts or associations.

TABLE 7.—COMPLETED PROJECTS OR DIVISIONS OF PROJECTS CONSTRUCTED BY THE BUREAU OF RECLAMATION AND OPERATED BY WATER-USERS' ORGANIZATIONS, JUNE, 1930

PROJECT AND STATE	ORGANIZATION
Salt River, Arizona	Salt River Valley Water-Users' Association.
Grand Valley, Orchard Mesa division, Colorado.	Orchard Mesa irrigation district.
Boise, Idaho	Board of Control, for Boise-Kuna, Nampa-Meridian (part of), Wilder, New York, Big Bend, and Black Canyon irrigation districts.
King Hill, Idaho	King Hill irrigation district.
Minidoka, Idaho:	
Gravity division	Minidoka irrigation district.
Pumping division	Burley irrigation district.
Huntley, Montana	Huntley irrigation district.
Milk River, Chinook division, Montana.	Alfalfa Valley irrigation district. Fort Belknap irrigation district. Harlem irrigation district. Paradise Valley irrigation district. Zurich irrigation district.
Sun River, Fort Shaw division, Montana.	Fort Shaw irrigation district.
North Platte, Nebraska-Wyoming:	
Interstate division	Pathfinder irrigation district.
Fort Laramie division	Gering-Fort Laramie irrigation district. Goshen irrigation district.
Northport division	Northport irrigation district.
Newlands, Nevada	Truckee-Carson irrigation district.
Umatilla, Oregon:	
East division	Hermiston irrigation district.
West division	West extension irrigation district.
Klamath, Langell Valley division, Oregon-California.	Langell Valley irrigation district. Horsefly irrigation district.
Strawberry Valley, Utah	Strawberry Valley Water-Users' Association.
Okanogan, Washington	Okanogan irrigation district.
Shoshone, Wyoming:	
Garland division	Shoshone irrigation district.
Frannie division	Deaver irrigation district.

The area irrigated in 1929 in the projects now operated by the two water-users' associations, named in Table 7, approximated 295,660 acres, as reported by the Commissioner of the United States Bureau of Reclamation, June 30, 1930. The area irrigated in the projects or divisions now operated by the irrigation districts named, approximated 719,610 acres. Thus the operation of systems serving more than 1,000,000 acres of the 1,485,028 acres credited to the United States Bureau of Reclamation in Table 5, has been assumed by the water users.

Carey Act enterprises show the smallest area irrigated in 1929 of any of the types shown in Table 5, except those classified as "State." The 1929 area, moreover, is somewhat smaller than that reported in 1919. Although a few areas were segregated under the provisions of the act during the 1919–1929 decade, actual development was principally confined to enterprises originally formed under the act, but later reorganized as enterprises of other types. In fact, Table 5 does not disclose the extent of the development which had been effected under the terms of the Carey Act in either 1929 or 1919, as is brought out by Table 8, which was compiled from annual reports of the Commissioner of the United States General Land Office to record the areas applied for, segregated, and patented under the Carey Act from 1921 to 1930. As the amounts are cumulative, they show, in fact, what has been accomplished under this act from the date of its passage in 1894.

TABLE 8.—AREAS APPLIED FOR, SEGREGATED, AND PATENTED, UNDER THE CAREY ACT

YEAR	APPLIED FOR—		SEGREGATED—		PATENTED—	
	To date	During year	To date	During year	To date	During year
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1921	8,389,624	12,651	3,788,626	5,178	982,711	76,381
1922	8,340,193	6,400	3,813,991	25,365	1,018,131	35,870
1923	8,366,801	26,607	3,815,106	1,115	1,069,623	51,492
1924	8,366,801	-------	3,842,393	27,287	1,137,324	67,700
1925	8,366,801	-------	3,843,290	897	1,158,926	21,602
1926	8,428,876	12,035	3,856,305	13,015	1,166,984	2,136
1927	8,462,522	33,646	3,870,730	14,425	1,168,276	1,292
1928	8,462,522	-------	3,870,730	-------	1,168,915	639
1929	8,462,522	-------	3,897,860	27,130	1,174,903	5,988
1930	8,465,601	3,079	3,897,860	-------	1,174,903	-------

The United States Bureau of Indian Affairs enterprises serve lands in Indian reservations. The area irrigated in 1929 was 16.6 per cent larger than the 1919 area, but both were small proportions of the totals.

The areas credited to "State" enterprises include, besides other enterprises, one land-settlement project established by the State of California prior to 1920, and a second similar project, also in California, established since 1920. At the time of the 1930 canvass both enterprises were in process of being turned over to cooperative water-users' companies, but the transfers had not actually been consummated. Between 1920 and 1930 several States undertook to foster land settlement and development under various plans, but none of these enterprises, except those in California, was operating under State management in 1930. Aside from the California projects, the enterprises classified as "State" were institutions watering gardens or small farms with their own supplies and are not considered as settlement or development projects.

The increase in areas credited to "City" enterprises represents largely a reclassification of California lands reported in the census of 1920 in the irrigation district group. These lands are irrigated from sources con-

trolled by the city of Los Angeles, which likewise controls the district organizations technically engaged in managing the distribution of portions of that city's water supply now available for irrigation. Progressively with the industrial and population growth of the city, this water is diverted from irrigation to other uses. Aside from these cases, the "City" group represents municipalities in various sections of the West, which maintain irrigation service as a distinct function of their city-water departments.

A unique development of the 1919–1929 decade is represented by the increase appearing in the group designated as "Other." This in part is attributable to the irrigation service rendered by several recently organized drainage districts. While many irrigation districts carry on drainage as well as irrigation operations, censuses previous to that of 1930 have not reported drainage districts which operate irrigation as well as drainage systems. The drainage districts involved in the classification are all in Oregon. The remainder of the 1930 group of "Other" enterprises is made up principally of California "reclamation" districts in the delta of Sacramento and San Joaquin Rivers, and in the Tulare Lake region. Reclamation districts have the primary function of flood protection, their principal works being dikes and levees. Many operate drainage systems also, while still others operate irrigation works. Large areas of the lands in the reclamation districts which themselves have no irrigation systems, are irrigated by individuals operating their own pumps or other irrigation works, but such areas are reported in the individual and partnership class. Of the several hundred reclamation districts, only the relatively few which operate irrigation works are enumerated in the census of irrigation.

Distribution, by source of water supply.—The areas irrigated in 1929 and 1919 and the increases in the intervening decade are distributed according to source of water supply in Table 9.

TABLE 9.—AREA IRRIGATED AND INCREASE, BY SOURCE OF WATER SUPPLY: 1929 AND 1919

SOURCE OF SUPPLY	LAND IRRIGATED				INCREASE [1]	
	1929		1919			
	Area	Proportion of total	Area	Proportion of total	Area	Per cent
	Acres	*Per cent*	*Acres*	*Per cent*	*Acres*	
Total	19,547,544	100.0	19,191,716	100.0	355,828	1.9
Streams, gravity	12,980,575	66.4	14,527,060	75.7	−1,546,485	−10.6
Streams, pumped	1,713,380	8.8	1,226,510	6.4	486,870	39.7
Streams, gravity and pumped	268,094	1.3	199,595	1.0	68,499	29.3
Wells, pumped	2,051,735	10.5	1,263,098	6.6	788,637	62.4
Wells, flowing	48,479	0.2	65,856	0.3	−17,377	−26.4
Wells, pumped and flowing	16,798	0.1	35,685	0.2	−18,887	−52.9
Lakes, pumped	77,818	0.4	35,730	0.2	42,088	117.8
Lakes, gravity	58,103	0.3	100,646	0.5	−42,543	−42.3
Springs	217,246	1.1	198,008	1.0	19,238	9.7
Stored storm water [2]	39,587	0.2	98,873	0.5	−59,286	−60.0
City water	1,654	(3)	930	(3)	724	77.8
Sewage	3,529	(3)	2,578	(3)	951	36.9
Streams, gravity and wells, pumped	1,104,349	6.0	344,713	1.8	819,636	237.8
Streams, gravity and wells, flowing	21,292	0.1	82,665	0.4	−61,373	−74.2
Other mixed	866,434	4.4	996,621	5.2	−130,187	−13.1
Other	8,069	(3)	13,148	0.1	15,323	116.5
Not reported	20,402	0.1				
Supplemental [4] from—						
Pumped streams	24,871					
Pumped wells	293,026					
Flowing wells	148					

[1] A minus sign (−) denotes decrease.
[2] In reservoirs filled from channels which carry water only during storms and are not classed as streams.
[3] Less than one-tenth of 1 per cent.
[4] Not considered in totals because included in enterprises reporting other sources of supply listed above. Corresponding figures for 1919 not available.

Conspicuous changes that appear in Table 9 show the decline of the area supplied by gravity from streams, and the increases in areas served by pumping from streams, wells, and lakes. Of lesser importance are the declines shown by areas served by flowing wells and stored storm water.

Notwithstanding the reduction of the "streams, gravity" area, it represents approximately two-thirds of the total area irrigated in 1929. The very large increase in the areas served by pumping from wells represents in part areas formerly served by small canals carrying water diverted from streams by gravity, the succession of years of low stream flow having done much, in some sections, to encourage the drilling of wells where they gave promise of yielding more dependable supplies. Likewise, the increase in areas served by pumping from streams partly represents the utilization of water from channels so located as not to be diverted economically by dams.

The decline in areas served by "stored storm water" is chiefly attributable to the low precipitation which affected some sections in 1929, to the extent of destroying the usefulness of the reservoirs formerly storing storm water, and to the fact that elsewhere many small reservoirs, previously reported as irrigation storage, are now used to collect drinking water for cattle.

Although many pumping plants and a few flowing wells were reported in 1919 as furnishing supplemental water for lands irrigated principally by gravity diversion from streams, the extent of the areas receiving the dual service was not reported; hence, no comparison with the 1929 areas reported as "supplemental" from pumped streams, pumped wells, and flowing wells is made in Table 9. These "supplemental" areas are not to be confused with the several areas reported elsewhere in the table as served by various combinations of sources, as for instance, "Streams, gravity and pumped." These combination classes represent areas served by enterprises the works of which include pumps or other equipment delivering water into the same systems that carry gravity supplies, no particular areas being reported under the different sources involved.

Because of the conspicuous increases in areas served entirely and partly by pumps, they are shown in expanded detail in the special section on pumping, beginning on page 34.

Distribution of area receiving water from different sources, by States.—The distribution, by States, of the area receiving water from the principal sources is shown in Tables 10, 11, and 12.

Of the area receiving its entire supply from streams in 1929, water diverted by gravity supplied nearly 87 per cent, that pumped supplied more than 11 per cent, while the area supplied in part by gravity and in part by pumping was nearly 2 per cent. The only States in which the area supplied by pumping exceeded the area supplied by gravity were Louisiana and Texas, the two States together accounting for nearly 46 per cent of the total area supplied by pumping from streams. California accounted for approximately 27 per cent additional. Idaho and Washington are the only other States showing areas in excess of 100,000 acres.

California shows slightly more than 69 per cent of the area receiving its entire supply from wells, showing also by far a greater acreage increase than any other State. Next to California are the rice-growing States of Arkansas and Louisiana, which, combined, reported approximately 15 per cent of the area. Arizona,

Texas, and New Mexico follow in the order named, no other State showing as much as 50,000 acres. Kansas and Oklahoma alone show smaller areas in 1929 than 1919, although the number of pumped wells in Kansas increased. No acreage was reported by North Dakota in either 1929 or 1919.

Of the area receiving its total supply from wells, pumped wells supplied 96.9 per cent in 1929. Flowing wells supplied 2.3 per cent, and mixed flowing and pumped wells less than 1 per cent. Montana is the only State where flowing wells supply a larger acreage than pumped wells, but both figures in this instance are insignificant. In 1919 New Mexico, Idaho, Montana, and Nevada showed a conspicuously larger area supplied by flowing wells than by pumped wells, but there, as in most localities where flowing wells formerly supplied extensive areas, pumped wells now supply much of them. However, slightly more than 45 per cent of the area still supplied by flowing wells is in New Mexico, Utah supplying an additional 19 per cent. New Mexico and California account for the greater part (approximately 93 per cent) of the total area served by both flowing and pumped wells. In the Pecos Valley of New Mexico and a few sections of southern California, some wells that originally flowed are now pumped, while others flow at times and are pumped at times. Thus in Pecos Valley especially, some wells previously reported as flowing are now reported as pumped, and classification of the areas involved is changed accordingly.

The area reported in Table 12 for "streams, gravity and wells, pumped," is that reported by enterprises utilizing sources of both classes indiscriminately for the irrigation of their lands. Most of these enterprises have streams as their principal dependence, pumping from their wells only when the gravity supplies

TABLE 10.—AREA RECEIVING ITS ENTIRE WATER SUPPLY FROM STREAMS, BY STATES: 1929 AND 1919

STATE	TOTAL		Increase [1]	GRAVITY		Increase [1]	PUMPED		Increase [1]	GRAVITY AND PUMPED		Increase [1]
	1929	1919		1929	1919		1929	1919		1929	1919	
Total (19 States)	*Acres* 14,962,049	*Acres* 15,953,165	*Per cent* −6.3	*Acres* 12,980,575	*Acres* 14,527,060	*Per cent* −10.6	*Acres* 1,713,380	*Acres* 1,226,510	*Per cent* 39.7	*Acres* 268,094	*Acres* 199,595	*Per cent* 20.3
Arizona	170,797	196,453	−13.1	162,621	189,782	−14.3	8,123	6,671	21.8	53		
Arkansas	1,502	6,129	−75.5		120	−100.0	1,502	6,009	−75.0			
California	2,254,772	2,920,396	−22.8	1,699,599	2,564,445	−33.7	469,944	295,673	58.9	85,160	60,278	41.3
Colorado	3,169,559	3,050,964	3.9	3,138,966	3,028,787	3.6	27,765	12,747	117.8	2,828	9,430	−70.0
Idaho	2,029,016	2,384,010	−14.9	1,848,760	2,274,959	−18.7	103,362	107,181	−3.6	76,894	1,870	
Kansas	56,412	32,137	75.5	53,196	30,807	72.7	3,216	730	340.5		600	−100.0
Louisiana	259,001	271,152	−4.5	1,611	10,226	−84.2	257,390	248,306	3.7		12,620	−100.0
Montana	1,487,751	1,550,827	−4.1	1,392,161	1,515,212	−8.1	38,620	15,743	145.3	56,970	19,872	186.7
Nebraska	503,653	437,532	15.1	501,195	435,567	15.1	2,458	1,115	120.4		850	−100.0
Nevada	395,236	470,179	−15.9	394,415	466,812	−15.5	821	2,647	−69.0		720	−100.0
New Mexico	436,955	434,368	0.6	430,099	432,478	−0.6	6,856	1,890	262.8			
North Dakota	8,253	11,499	−28.2	6,584	9,030	−27.1	1,669	2,469	−32.4			
Oklahoma	675	2,710	−75.1	355	2,522	−85.9	320	188	70.2			
Oregon	739,569	851,133	−13.1	674,396	786,354	−14.2	50,537	64,576	−21.7	14,636	253	
South Dakota	65,916	93,360	−29.4	65,855	92,491	−28.8	61	869	−93.0			
Texas	699,146	495,870	41.0	168,246	73,982	127.4	527,700	421,538	25.2	3,200	350	814.3
Utah	1,040,577	1,116,130	−6.8	962,568	1,105,691	−12.9	63,809	10,389	514.2	14,200	50	
Washington	450,067	471,145	−4.5	306,185	352,199	−13.1	139,738	26,244	432.4	4,144	92,702	−95.5
Wyoming	1,183,252	1,157,121	2.3	1,173,763	1,155,596	1.6	9,489	1,525	522.2			

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

TABLE 11.—AREA RECEIVING ITS ENTIRE WATER SUPPLY FROM WELLS, BY STATES: 1929 AND 1919

STATE	TOTAL		Increase [1]	PUMPED		Increase [1]	FLOWING		Increase [1]	PUMPED AND FLOWING		Increase [1]
	1929	1919		1929	1919		1929	1919		1929	1919	
Total (18 States) [2]	*Acres* 2,117,012	*Acres* 1,364,689	*Per cent* 55.1	*Acres* 2,051,735	*Acres* 1,263,098	*Per cent* 62.4	*Acres* 48,479	*Acres* 65,856	*Per cent* −26.4	*Acres* 16,798	*Acres* 35,685	*Per cent* −52.9
Arizona	106,002	41,810	153.5	104,637	39,694	163.6	1,107	1,558	−28.9	258	558	−53.8
Arkansas	142,978	135,260	5.7	142,978	135,260	5.7						
California	1,464,960	868,060	68.8	1,453,272	826,846	75.8	1,927	17,653	−89.1	9,761	23,561	−58.6
Colorado	15,929	14,390	10.7	12,143	10,114	20.1	3,786	4,191	−9.7		85	−100.0
Idaho	5,569	1,545	260.5	3,546	414	756.5	1,973	1,131	74.4	50		
Kansas	11,651	13,285	−12.3	11,648	13,235	−12.0	3				50	−100.0
Louisiana	175,787	155,575	13.0	172,695	154,304	11.9	2,896	196		196	1,075	−81.8
Montana	1,064	351	203.1	243	139	74.8	821	212	287.3			
Nebraska	23,452	546		23,452	546							
Nevada	3,426	1,171	192.6	2,117	295	617.6	1,132	811	39.6	177	65	172.3
New Mexico	58,118	52,295	11.1	30,425	15,709	93.7	21,838	30,030	−27.3	5,855	6,556	−10.7
Oklahoma	63	125	−49.6	63	107	−41.1		18	−100.0			
Oregon	3,891	2,405	61.8	3,804	1,993	90.9	87	72	20.8		340	−100.0
South Dakota	528	130	306.2				528	130	306.2			
Texas	62,624	44,466	40.8	60,793	39,483	54.0	1,831	3,256	−43.8		1,727	−100.0
Utah	19,655	12,394	58.6	10,283	7,308	40.7	8,974	4,908	82.8	398	178	123.6
Washington	20,995	20,665	1.6	19,456	17,504	11.2	1,436	1,671	−14.1	103	1,490	−93.1
Wyoming	320	166	92.8	180	147	22.4	140	19	636.8			

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

[2] None reported for North Dakota.

are low. Areas classed as "supplemental from pumped wells" are similarly situated, except that the wells are owned and operated by enterprises independent of those operating the gravity-canal systems. Ignoring the supplemental classification, which applies to relatively small areas outside of California, that State still accounts for more than 67 per cent of the total supplied from those sources. Arizona shows an additional 25 per cent, most of the area involved being in the Salt River project of the United States Bureau of Reclamation. Most of the water serving this large project in normal years is diverted from Salt River by gravity, but a large number of wells, sunk in places within the irrigated area where the ground water had risen so close to the surface as to create a serious drainage menace, discharge into the irrigation canals. Originally planned as drainage wells, by supplementing the river water carried by the canals, these wells now contribute an important addition to the project's irrigation supply while also functioning as drains, especially in years of low river supplies such as 1929.

TABLE 12.—AREA RECEIVING ITS WATER SUPPLY FROM MIXED SOURCES, BY STATES: 1929 AND 1919

STATE	TOTAL [1]		Increase [2]	STREAMS, GRAVITY AND WELLS, PUMPED		Increase [2]	STREAMS, GRAVITY AND WELLS, FLOWING		Increase [2]	OTHER MIXED		Increase [2]	Supplemental from pumped streams, pumped wells, and flowing wells, 1929 [3]
	1929	1919		1929	1919		1929	1919		1929	1919		
	Acres	*Acres*	*Per cent*	*Acres*	*Acres*	*Per cent*	*Acres*	*Acres*	*Per cent*	*Acres*	*Acres*	*Per cent*	*Acres*
Total (19 States)	2,052,075	1,423,999	44.1	1,164,349	344,713	237.8	21,292	82,665	−74.2	866,434	996,621	−13.1	318,045
Arizona	294,608	226,014	30.3	292,681	217,799	34.4	40	525	−92.4	1,887	7,690	−75.5	1,725
Arkansas	6,750	2,067	226.6	----------	250	−100.0	----------	----------	----------	6,750	1,817	271.5	----------
California	969,640	320,576	202.5	780,960	87,897	788.5	2,222	4,255	−47.8	186,458	228,424	−18.4	289,589
Colorado	176,105	249,963	−29.5	8,956	16,258	−44.9	8,700	67,880	−87.2	158,539	165,825	−4.4	1,870
Idaho	107,463	56,885	88.9	72,959	357	----------	1,708	1,927	−11.4	32,796	54,601	−39.9	9,047
Kansas	458	1,890	−75.8	405	1,540	−73.7	----------	----------	----------	53	350	−84.8	1,050
Louisiana	11,695	17,880	−34.6	----------	10,045	−100.0	----------	----------	----------	11,695	7,835	49.3	260
Montana	79,426	95,293	−16.7	2,694	155	----------	----------	6,008	−100.0	76,732	89,070	−13.8	----------
Nebraska	2,329	1,235	88.6	70	115	−39.1	----------	----------	----------	2,259	1,120	101.7	----------
Nevada	25,680	50,215	−48.8	2,260	4,957	−54.4	2,274	82	----------	21,152	45,176	−53.2	----------
New Mexico	20,516	31,813	−35.5	655	1,341	−51.2	360	685	−47.4	19,501	29,787	−34.5	20
North Dakota	----------	65	−100.0	----------	----------	----------	----------	----------	----------	----------	65	−100.0	----------
Oklahoma	40	125	−68.0	----------	----------	----------	----------	----------	----------	40	125	−68.0	----------
Oregon	127,324	111,442	14.3	994	105	846.7	2,328	200	----------	124,002	111,137	11.6	8,499
South Dakota	160	4,384	−96.4	----------	500	−100.0	160	20	700.0	----------	3,864	−100.0	----------
Texas	20,097	24,669	−18.5	850	454	87.2	----------	45	−100.0	19,247	24,170	−20.4	254
Utah	154,191	174,157	−11.5	20	125	−84.0	3,500	537	551.8	150,671	173,495	−13.2	972
Washington	16,803	21,883	−22.9	708	2,415	−70.7	----------	441	−100.0	16,155	19,027	−15.1	4,759
Wyoming	38,634	33,443	15.5	137	400	−65.8	----------	----------	----------	38,497	33,043	16.5	----------

[1] Not including "Supplemental." [2] A minus sign (−) denotes decrease. Per cent not shown when more than 1,000. [3] Not reported in 1919.

Approximately 41 per cent of the area receiving water from both streams and flowing wells in 1929 is in Colorado. An additional 16 per cent is in Utah, while Oregon, Nevada, and California together account for about 32 per cent. The area served by this combination of sources was relatively small in both 1929 and 1919, the total for the later year being little more than one-fourth that of the earlier year, reflecting again the declining usefulness of flowing wells in irrigation service.

"Other mixed" includes so many different combinations that an analysis of the group is not here possible. Such of the areas as are partly served by pumps are included in the classifications presented in Table 36, page 37.

AREA ENTERPRISES WERE CAPABLE OF SUPPLYING WITH WATER AND AREA INCLUDED IN ENTERPRISES

The area enterprises were capable of supplying with water and the area in enterprises have been tabulated in the Fifteenth and Fourteenth Censuses as an indication of the degree to which existing irrigation works are utilized and the opportunity they contain for further development. The geographical distribution, by States, of the area enterprises were capable of supplying with water in 1930 and 1920; and the excess of these items over the areas irrigated in 1929 and 1919, are shown in Table 13.

TABLE 13.—AREA ENTERPRISES WERE CAPABLE OF SUPPLYING WITH WATER IN 1930 AND 1920, AND EXCESS IN THESE AREAS OVER AREAS IRRIGATED IN 1929 AND 1919, BY STATES

STATE	1930		1920		Increase [1] of excess over area irrigated, 1920–1930
	Area	Excess over area irrigated in 1929	Area	Excess over area irrigated in 1919	
	Acres	*Acres*	*Acres*	*Acres*	*Per cent*
Total (19 States)	26,101,800	6,554,346	26,020,477	6,828,761	−4.0
Arizona	824,152	248,562	627,303	159,738	55.6
Arkansas	209,042	58,155	179,013	35,067	65.8
California	6,815,250	2,068,618	5,894,406	1,675,426	23.5
Colorado	4,078,712	685,093	3,855,348	508,963	35.1
Idaho	2,617,021	435,771	3,092,810	604,004	−27.9
Kansas	83,583	12,203	67,853	20,541	−40.2
Louisiana	795,165	344,264	728,742	273,800	25.7
Montana	2,276,000	681,088	2,753,498	1,071,769	−36.5
Nebraska	703,641	171,024	562,468	119,778	42.8
Nevada	736,249	249,601	704,708	143,261	74.2
New Mexico	656,669	129,636	696,119	157,742	−17.8
North Dakota	24,006	14,614	34,235	22,163	−34.1
Oklahoma	7,331	5,758	9,672	6,703	−14.1
Oregon	1,158,210	259,497	1,344,046	357,884	−27.5
South Dakota	109,550	42,443	150,914	50,232	−15.5
Texas	1,177,415	378,498	1,150,542	564,422	−32.9
Utah	1,542,475	218,350	1,700,550	328,899	−33.6
Washington	631,511	132,228	637,151	107,252	23.3
Wyoming	1,655,008	418,853	1,831,039	623,057	−32.8

[1] A minus sign (−) denotes decrease.

As shown in Table 13, existing enterprises were capable in 1930 of supplying 6,554,346 acres in addition to the area irrigated in 1929. In other words, a normal water supply and improved economic conditions in western agriculture would permit an increase of more than one-third in the area actually irrigated in 1929, without the construction of new works or the extension of existing works. This marks a reduction of 274,415 acres from the corresponding figure reported in 1920, indicating that the relatively small increase in area irrigated in 1929 over that irrigated in 1919 had not been effected so much by new construction as by putting into production land already susceptible of being served by existing works. This has been true only in a general sense, however, as Table 13 itself shows without consideration of tables to follow which disclose the extent of the increase in investment in irrigation works in the decade. Thus Arizona, Arkansas, California, Colorado, Kansas, Louisiana, Nebraska, Nevada, and Texas show for 1930, larger areas capable of being served by existing works than were reported in 1920, the reduction in the total excess for the 19 States being attributable to the reductions reported by Idaho, Kansas, Montana, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, and Wyoming. Moreover, of this group of States, all except Kansas, Texas, and Wyoming show, in the 1930 census, reduced areas irrigated as well as reduced areas susceptible of being served.

According to Table 13, approximately 32 per cent of the total unirrigated area which existing systems are capable of supplying, is in California, 10 per cent in Colorado, 10 per cent in Montana, 7 per cent in Idaho, 6 per cent in Wyoming, 6 per cent in Texas, and 5 per cent in Louisiana. No other State has as much as 5 per cent of the total.

The excess area consists in part of land in existing farms which is not yet watered and in part of land not yet settled but available, or to be 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, or to be available, for settlement, and the total area reported by the enterprises reporting this item was 1,681,598 acres. (See Table 18.) This is slightly more than one-fourth of the difference between the total area existing enterprises could supply in 1930 and the area irrigated in 1929.

Table 14 distributes the 1930 and 1920 excess by character of enterprise.

Approximately 24 per cent of the 1930 excess area is reported by individual and partnership enterprises. This includes only a few small areas reported as available for settlement, being principally land in individual farms which was not watered for various reasons, in 1929. Approximately the same proportion of the excess area is reported by cooperative enterprises. This also principally represents land in farms that was not watered, rather than land available for settlement, although it includes a larger area so available than the individual and partnership group.

Of the remaining groups which together comprise approximately 52 per cent of the total, irrigation districts include the largest proportion of the excess area or nearly 21 per cent. This represents an increase of 685,282 acres in the excess area reported by irrigation districts, which were shown by Table 5 to have experienced the most extensive development of any type during the 1919–1929 decade.

TABLE 14.—AREA ENTERPRISES WERE CAPABLE OF SUPPLYING WITH WATER, 1930 AND 1920, AND EXCESS OF THESE AREAS OVER AREAS IRRIGATED IN 1929 AND 1919, BY CHARACTER OF ENTERPRISE

CHARACTER OF ENTERPRISE	1930		1920		Increase[1] of excess over area irrigated, 1920–1930
	Area	Excess over area irrigated in 1929	Area	Excess over area irrigated in 1919	
	Acres	*Acres*	*Acres*	*Acres*	*Per cent*
Total	26,101,890	6,554,346	26,020,477	6,828,761	−4.0
Individual and partnership	7,982,142	1,571,561	9,255,750	2,406,949	−34.7
Cooperative	7,861,081	1,589,747	8,403,298	1,821,808	−12.7
Irrigation district	4,846,095	1,393,820	2,531,425	708,538	96.7
Carey Act	174,246	87,474	804,298	280,369	−68.8
Commercial	2,160,950	930,187	2,799,563	977,562	−4.8
United States Bureau of Indian Affairs	739,446	407,606	484,486	199,935	103.9
United States Bureau of Reclamation	1,944,825	459,797	1,680,643	426,074	7.9
State	13,600	2,111	7,379	1,759	20.0
City	146,132	24,914	44,458	4,312	477.8
Other	233,373	87,129	8,546	1,310	
Not reported			625	55	−100.0

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

Commercial enterprises report approximately 14 per cent of the total, the area involved being only slightly reduced from that reported in 1919.

Next to commercial enterprises, United States Bureau of Reclamation enterprises report the largest proportion of the total excess area, 7 per cent. Approximately 6.2 per cent is reported by the United States Bureau of Indian Affairs enterprises. The largest proportionate increase in the excess, aside from that for the group of "other" enterprises, is that shown for city enterprises, but the acreage is relatively small. The increase for the United States Bureau of Indian Affairs enterprises is large, both proportionately and in acreage, being made up principally of extensive projects in course of development in 1930.

Irrigation districts, Carey Act enterprises, commercial enterprises, United States Bureau of Reclamation enterprises, and United States Bureau of Indian Affairs enterprises, the classes of enterprises engaged extensively in reclaiming new land, together reported 50 per cent of the total excess. The excess areas so reported by the group totals 3,278,884 acres. The area reported in Table 18 as available, or to be available, for settlement, is 1,681,598 acres. Thus it appears that about one-fourth the unirrigated excess which could be irrigated with existing systems, represents land outside of existing farms and available for settlement.

These statistics indicate that irrigation works, taken as a whole, were utilized to about three-fourths of their available capacity in 1929. Table 15 shows the extent to which works belonging to the various principal classes of enterprises were utilized, as represented by the ratio between the areas they were capable of supplying with water in 1930 and the areas

irrigated in 1929. Similar ratios representing the irrigation census of 1920 are also shown.

TABLE 15.—PROPORTION WHICH AREA IRRIGATED IS OF AREA ENTERPRISES WERE CAPABLE OF SUPPLYING WITH WATER, BY CHARACTER OF ENTERPRISE: 1930 AND 1920

CHARACTER OF ENTERPRISE	PROPORTION	
	1930	1920
Total	*Per cent* 74.9	*Per cent* 73.8
Individual and partnership	80.3	74.0
Cooperative	79.8	78.3
Irrigation district	71.2	72.0
Carey Act	49.8	65.1
Commercial	57.0	65.1
United States Bureau of Indian Affairs	44.9	58.7
United States Bureau of Reclamation	76.4	74.6

The areas included in enterprises in 1930 and 1920, with the excesses in these areas over the areas irrigated in 1929 and 1919, are shown in Table 16. Because the 1930 figures represent irrigable area, while the 1920 figures represent total area, the two columns representing excesses over irrigated areas are not strictly comparable; hence no percentages of change are shown.

TABLE 16.—AREA IN ENTERPRISES, 1930 AND 1920, AND THE EXCESS OF THESE AREAS OVER THE AREAS IRRIGATED IN 1929 AND 1919, BY STATES

STATE	Irrigable area, 1930	Excess over area irrigated in 1929	Total area, 1920	Excess over area irrigated in 1919
Total (19 States)	*Acres* 30,599,470	*Acres* 11,051,926	*Acres* 35,890,821	*Acres* 16,699,105
Arizona	1,085,627	510,037	813,153	345,688
Arkansas	225,992	74,205	246,480	102,534
California	8,075,895	3,329,263	7,805,207	3,586,167
Colorado	4,528,251	1,134,632	5,220,588	1,872,203
Idaho	2,814,048	632,798	3,780,048	1,291,242
Kansas	95,719	24,429	102,562	55,250
Louisiana	350,401	399,500	851,211	396,320
Montana	2,622,423	1,027,511	4,329,148	2,647,419
Nebraska	703,039	230,422	766,768	324,078
Nevada	983,717	497,069	1,382,036	820,589
New Mexico	741,245	214,212	961,879	423,502
North Dakota	24,860	15,498	57,476	45,404
Oklahoma	7,344	5,771	11,742	8,773
Oregon	1,478,128	579,415	1,925,987	939,825
South Dakota	122,510	55,403	188,382	87,700
Texas	1,566,876	767,959	1,687,447	1,101,327
Utah	1,739,869	415,744	2,359,244	987,593
Washington	915,379	416,096	836,795	306,896
Wyoming	1,958,147	721,992	2,564,668	1,356,686

The excess of the irrigable area in enterprises in 1930 over the area irrigated in 1929 was 11,051,926 acres, or slightly more than one-third of the irrigable area in enterprises; that is, all enterprises taken together are irrigating not quite two-thirds of the land included in their plans. The excess area is approximately 57 per cent as large as the area irrigated in 1929; hence, the completion and full utilization of all existing enterprises, provided all areas now considered as irrigable actually are so, would permit an increase of more than one-half in the area irrigated in 1929.

The distribution of the areas in enterprises in 1930 and 1920 and the excesses over the areas irrigated, by character of enterprise, are shown in Table 17.

TABLE 17.—AREA IN ENTERPRISES, 1930 AND 1920, AND THE EXCESS OF THESE AREAS OVER THE AREAS IRRIGATED IN 1929 AND 1919, BY CHARACTER OF ENTERPRISE

CHARACTER OF ENTERPRISE	Irrigable area, 1930	Excess over area irrigated in 1929	Total area, 1920	Excess over area irrigated in 1919
Total	*Acres* 30,599,470	*Acres* 11,051,926	*Acres* 35,890,821	*Acres* 16,699,105
Individual and partnership	8,969,051	2,558,470	13,008,415	6,159,608
Cooperative	8,098,800	2,427,466	10,628,543	4,047,143
Irrigation district	6,013,347	2,561,072	3,432,109	1,609,222
Carey Act	192,246	105,474	1,188,937	665,008
Commercial	2,619,597	1,388,834	3,999,581	2,177,580
United States Bureau of Indian Affairs	1,122,134	790,294	932,985	648,434
United States Bureau of Reclamation	2,569,649	1,084,021	2,627,176	1,372,607
State	14,231	2,742	9,581	3,961
City	140,534	19,316	49,650	9,504
Other	259,881	113,637	13,144	5,908
Not reported			700	130

Table 18 shows the areas, by States, reported in the Fifteenth and Fourteenth Censuses as available, or to be available, for settlement, with the proportions they constitute of (1) the difference between the irrigable area in enterprises and the area enterprises were capable of supplying with water in 1930, and (2) the difference between the irrigable area and the area irrigated in 1929. As regards the first comparison, it is apparent that some areas of considerable extent in Oregon and Utah are reported as available, or to be available, for settlement, to which existing enterprises are already capable of supplying water, although the areas were not irrigated in 1929. Although not in like ratio, such circumstances exist in many localities in other States, as development enterprises customarily carry construction ahead of colonization in order to make their farms attractive to settlers.

TABLE 18.—AREA IN ENTERPRISES AVAILABLE, OR TO BE AVAILABLE, FOR SETTLEMENT, BY STATES: 1930 AND 1920

STATE	AREA AVAILABLE, OR TO BE AVAILABLE, FOR SETTLEMENT		PROPORTION OF EXCESS OF IRRIGABLE AREA IN ENTERPRISES, 1930, OVER—	
	1930	1920	Area enterprises were capable of supplying with water, 1930	Area irrigated in 1929
Total (15 States) [1]	*Acres* 1,081,598	*Acres* 2,257,981	*Per cent* 37.4	*Per cent* 15.2
Arizona	164,693	24,341	63.0	32.3
California	158,087	533,981	12.6	4.8
Colorado	88,731	274,282	19.7	7.8
Idaho	79,972	118,334	40.6	12.6
Louisiana	15,440		28.0	3.9
Montana	53,576	207,530	15.5	5.2
Nebraska	10,113		17.0	4.4
Nevada	92,026	139,352	37.6	18.7
New Mexico	42,811	66,479	50.6	20.0
Oregon	330,475	98,609	103.3	57.0
South Dakota	5,000		38.6	9.0
Texas	80,323	346,446	20.6	10.5
Utah	199,449	189,563	101.0	48.0
Washington	195,041	61,738	68.7	46.9
Wyoming	164,361	197,326	54.2	22.8

[1] No areas available for settlement reported for Arkansas, Kansas, North Dakota, and Oklahoma in 1930; nor for Arkansas, Kansas, Louisiana, Nebraska, North Dakota, Oklahoma, and South Dakota for 1920.

AGE OF ENTERPRISES AND RATE OF DEVELOPMENT

Table 4, page 50, and the corresponding State tables in later pages, show the area irrigated in 1929 and the 1930 irrigable area in enterprises, by the date of beginning. The ratios between these areas as shown in Table 4 are repeated in Table 19, which also shows the ratios obtained in the census of 1920 between the area irrigated in 1919 and the 1920 total area in enterprises.

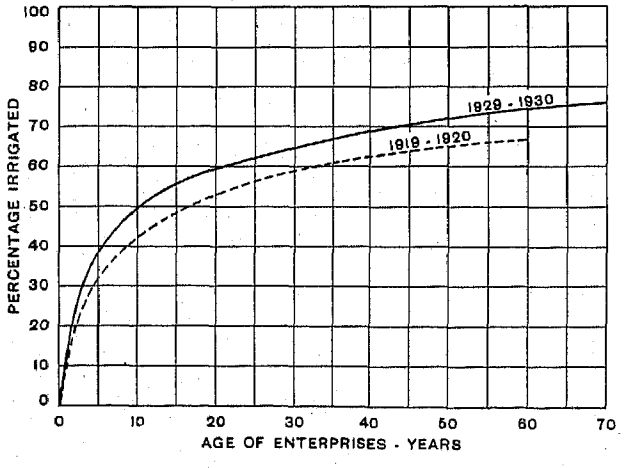
TABLE 19.—RATE OF DEVELOPMENT OF IRRIGATION ENTERPRISES, BY AGE

AGE OF ENTERPRISE	RATIO, AREA IRRIGATED IN—	
	1929 to irrigable area in enterprises, 1930	1919 to total area in enterprises, 1920
	Per cent	*Per cent*
All enterprises	63.9	53.5
Up to 5 years	50.9	35.8
5 to 10 years	48.0	39.1
10 to 15 years	57.8	43.5
15 to 20 years	58.7	57.6
20 to 25 years	61.1	
20 to 30 years		55.6
25 to 30 years	60.7	
30 to 40 years	56.8	64.6
40 to 50 years	74.4	61.0
50 to 60 years	69.9	66.9
More than 60 years		63.9
60 to 70 years	82.0	
More than 70 years	68.2	
Not reported	78.3	63.2

Since total area and irrigable area are not synonymous (see page 4), no measurement of change between 1920 and 1930 ratios is attempted in Table 19, but both are used in Figure 2 to plot the approximate

FIGURE 2.—RATE OF DEVELOPMENT OF IRRIGATION ENTERPRISES

[The vertical scale represents, for the 1929-30 curve, the ratio of the area irrigated in 1929 to the irrigable area in enterprises in 1930; and for the 1919-20 curve, the ratio of the area irrigated in 1919 to the total area in enterprises in 1920.]



curves describing the rate at which land in irrigation enterprises has been brought under irrigation.[1] In Figure 2, the horizontal scale represents the age of the reporting enterprises as represented by the date-of-beginning groups shown in Table 4, page 50, while the vertical scale marks the ratios set out in Table 19.

The curve based on the Fifteenth Census figures presents a more favorable picture of the rate of development than the curve based on the Fourteenth Census returns, principally because the 1930 ratio involves the irrigable rather than the total area in projects. Both curves, while no more than approximations,[2] indicate that about half the lands in the average irrigation project are brought under irrigation in the first 10 or 15 years of its existence, but that reclamation of the remaining half is much slower. The 1930 curve indicates that a three-fourths development has been accomplished by the end of about 70 years. If further examinations and surveys should serve, as have those made in recent years, to eliminate from extensive projects many large areas which at present are considered as ultimately irrigable, the 1930 curve will properly be subject to revision such as it now represents with reference to the 1920 curve.

Summary Table 4, page 50, shows that about 30 per cent of the enterprises included in the census of 1930 failed to report their dates of beginning. However, nearly three-fourths of the nonreporting establishments are in California, and represent small supplemental pumping enterprises serving areas in larger enterprises of other types which reported dates. The irrigated acreage not reporting dates was 7.6 per cent of the total.

AREA, BY CHARACTER OF WATER RIGHTS

All States included in the census of irrigation, except Arkansas and Louisiana, have assumed some measure of public control over irrigation and rights to water. In each of the arid States, the laws recognize the right of those needing water for irrigation or other beneficial purposes to "appropriate" it from streams and other sources. This right is limited in various ways, and all the States prescribe some procedure which shall be followed in exercising it. However, all these States have in the past recognized rights acquired by merely taking and using water, in the absence of laws, or without conforming to the laws, when there were such. All rights acquired in this way that have not been passed upon by the courts or by some official body to which has been given the right to adjudicate water rights, are reported in the "appropriation" class in the census of irrigation.

The first step in the public regulation of the appropriation of water was the enacting of laws requiring those intending to take water from streams or other sources to post notices at the points of intended diversion and to file copies of these notices with some public official, usually the county clerk or county recorder. In some cases notices were filed only. The names of the States in which such laws were enacted with the dates of enactment and the dates on which they were superseded by other laws are shown in Table 20. The practice of posting and filing notices was so general that many notices were filed in States where there was no legislation on the subject.

[1] The curve based on enterprises reported in the census of 1920 is drawn after Teele, U. S. Department of Agriculture Bulletin No. 1757, p. 32.

[2] The points against which the curves are drawn assume that all enterprises in each date group have the maximum age involved. Thus all enterprises begun between 1924 and 1929 are considered to be 5 years old, etc.

TABLE 20.—DATE OF LAW REQUIRING POSTING OR FILING OF NOTICES OF APPROPRIATION AND DATE WHEN SUPERSEDED, BY STATES

STATE	DATE OF LAW		STATE	DATE OF LAW	
	Enactment	When superseded		Enactment	When superseded
Arizona	1893	1919	North Dakota	[3] 1881	1905
California	1872	1913	Oklahoma	1897	1905
Colorado	[1] 1881	(1)	Oregon	1905	1909
Idaho	1881	1903	South Dakota	[3] 1881	1905
Kansas	1886	(2)	Texas	1889	1913
Montana	1885	(2)	Utah	1897	1903
Nebraska	1889	1895	Washington	1890	1917
Nevada	1866	1889	Wyoming	1886	1890
New Mexico	1891	1907			

[1] Declared unconstitutional; reenacted in different form in 1903. [2] Still in force.
[3] Territory of Dakota.

The laws of the various States and the periods during which they were in force are shown in Table 21.

TABLE 21.—METHODS OF DEFINING RIGHTS TO WATER AND PERIODS OF TIME DURING WHICH THEY HAVE BEEN IN FORCE, BY STATES

STATE	Defined by courts without the aid of State officials or board	Defined by courts on basis of information collected by State officials or board	Defined by State officials or board
Arizona	Until 1919	1919 to date	
Arkansas	To date		
California	Until 1914 [1]	1914 to date	
Colorado	To date		
Idaho	To date [2]	(3)	
Kansas	To date [2]		
Louisiana	To date [2]		
Montana	To date [2]		
Nebraska	Until 1895		1895 to date.
Nevada	Until 1903	1915 to date	1903 to 1915.
New Mexico	Until 1907	1907 to date	
North Dakota	Until 1905	1905 to date	
Oklahoma	Until 1905	1905 to date	
Oregon	Until 1909 [4]	1909 to date	
South Dakota	To date [5]		
Texas	To date [5]		
Utah	Until 1903	1903 to date	
Washington	Until 1917	1917 to date	
Wyoming	Until 1890		1890 to date.

[1] Law passed in 1913, but withheld by referendum until 1914.
[2] Law providing otherwise declared unconstitutional. However, portion of law providing that courts may request aid of State engineer (now department of reclamation) has been held valid.
[3] Discretionary with courts, 1903 to date.
[4] Participation by State engineer in certain suits from 1905 to 1909.
[5] Law providing otherwise declared unconstitutional.

The fact that many rights to water have been acquired without public supervision and consequently are not defined as to date or extent when they are acquired has created the necessity for the defining of such rights by some public authority. Originally rights were defined in ordinary suits between water users whose claims conflicted, but this led to such a multiplicity of suits that most of the States in which irrigation is generally practiced have enacted laws providing either some special procedure in the courts for the adjudication of rights, or for adjudication by some board or official, or for a combination of the two systems in which testimony is taken, surveys are made, and decrees are prepared by boards or officials, but the decrees are issued by the courts. In all the States, rights were defined by the courts before any other system was adopted, and some of the States have changed their systems more than once.

The States named in Table 22 require that those wishing rights to water shall apply to a designated State board or official for a permit, and further provide for the issuing of a certificate or license setting forth the rights acquired.

TABLE 22.—STATES AND DATE OF LAW REGULATING THE ISSUANCE OF PERMITS, CERTIFICATES, OR LICENSES

STATE	Date of law	STATE	Date of law
Arizona	1919	Oklahoma	1905
California	1913	Oregon	1909
Idaho	1903	South Dakota	1905
Nebraska	1895	Texas	1913
Nevada	1905	Utah	1903
New Mexico	1907	Washington	1917
North Dakota	1905	Wyoming	1890

The States that recognize riparian rights to some extent are as follows: California, Kansas, Nebraska, North Dakota, Oklahoma, Oregon, South Dakota, Texas, and Washington.

Areas irrigated in 1929 and 1919 under rights of the classes recognized in the census of irrigation are shown in Summary Table 7, page 51, and the corresponding State tables. Table 23 shows the proportion of the irrigated area which each of these classes represents.

TABLE 23.—PROPORTION OF AREA IRRIGATED IN 1929 AND 1919, BY CHARACTER OF WATER RIGHTS, BY STATES

STATE	APPROPRIATION AND USE		NOTICE FILED AND POSTED		ADJUDICATED BY COURT		PERMIT FROM STATE		CERTIFICATE OR LICENSE FROM STATE		RIPARIAN		UNDERGROUND		OTHER, MIXED, AND NOT REPORTED	
	1929	1919	1929	1919	1929	1919	1929	1919	1929	1919	1929	1919	1929	1919	1929	1919
Total (19 States)	*Per cent* 10.0	*Per cent* 13.1	*Per cent* 9.5	*Per cent* 14.4	*Per cent* 40.3	*Per cent* 37.3	*Per cent* 14.9	*Per cent* 10.2	*Per cent* 5.9	*Per cent* 6.7	*Per cent* 2.7	*Per cent* 1.9	*Per cent* 9.0	*Per cent* 5.6	*Per cent* 7.7	*Per cent* 10.7
Arizona	4.2	48.5	16.2	20.8	58.2	18.2	1.3	(1)	0.7				16.3	8.9	3.1	3.6
Arkansas															100.0	100.0
California	8.4	11.4	15.2	16.7	16.4	23.2	14.0	1.9	0.6	0.6	7.5	5.7	30.6	20.5	7.3	20.0
Colorado	5.8	3.4	4.6	6.2	88.5	87.2							0.5	0.4	0.6	2.8
Idaho	6.6	5.3	1.9	9.6	53.2	44.4	19.4	19.6	15.5	13.6			0.2	0.1	3.1	7.4
Kansas	15.6	55.9	41.3	8.9	17.7	0.9					0.1	0.1	16.3	28.5	9.0	5.7
Louisiana															100.0	100.0
Montana	14.2	13.7	29.5	39.6	50.5	41.7									5.7	4.7
Nebraska	4.3	9.5	4.0	3.7	22.3	2.1	52.0	53.0	12.1	26.6		0.3	0.1	(1)	5.3	4.7
Nevada	27.0	35.7	1.2	0.3	33.3	28.7	23.8	19.0	1.8	1.2		0.1	4.4	0.1	0.9	4.7
New Mexico	47.2	28.4	2.1	10.1	17.5	17.1	17.8	19.2	5.6	3.7			0.4	0.2	12.5	5.9
North Dakota	15.6	52.6	64.9	19.3	10.2		0.3	24.3	1.9			0.1	8.5	9.7	1.3	11.7
Oklahoma	17.9	1.2		7.2		74.1	21.6	10.4	7.6		1.1	2.7	5.0	4.0	46.8	0.3
Oregon	6.4	15.1	7.4	15.3	44.4	29.8	13.2	13.3	12.6	22.0	10.3	1.5	0.4	0.3	5.3	2.7
South Dakota	0.6	1.8	57.2	61.6	17.4	7.6	8.8	17.4	4.4	8.5	5.0	1.6	0.8	0.1	5.8	1.4
Texas	9.7	11.8	0.9	17.9	6.2	0.5	56.4	39.2	6.7	2.0	6.0	12.4	7.7	7.6	6.4	8.6
Utah	18.5	34.3	1.6	12.5	49.2	42.4	10.1	4.1	11.7	4.9			1.5	0.6	7.4	1.2
Washington	11.2	37.1	27.3	32.0	15.0	10.6	26.3	7.5	4.2	3.3	5.9	3.2	3.5	3.9	6.6	2.2
Wyoming	9.4	2.1	2.2	5.0	17.6	13.4	39.8	38.6	27.7	37.8			(1)	(1)	3.3	3.0

[1] Less than one-tenth of 1 per cent.

In Table 24, the percentages appearing in Table 23 under the classifications "adjudicated," "permit from State," and "certificate or license from State," are assembled to show the proportion of the irrigated area which is supplied with water under defined rights. This shows, for all States, an increase from 54.2 per cent in 1919 to 61.1 per cent in 1929, only North Dakota, Oklahoma, South Dakota, and Wyoming showing smaller areas irrigated under defined rights in 1929 than in 1919. Marked increases are those reported by Arizona, Texas, Utah, and Washington.

TABLE 24.—PROPORTION OF AREA IRRIGATED IN 1929 AND 1919 THAT IS SUPPLIED WITH WATER UNDER DEFINED RIGHTS, BY STATES

STATE	1929	1919	STATE	1929	1919
	Per cent	*Per cent*		*Per cent*	*Per cent*
Total (17 States)[1]	61.1	54.2	New Mexico	40.9	40.0
			North Dakota	12.4	24.3
Arizona	60.2	18.2	Oklahoma	29.2	84.5
California	31.0	25.8	Oregon	70.2	65.1
Colorado	88.5	87.2	South Dakota	30.6	33.6
Idaho	88.1	77.6	Texas	69.3	41.7
Kansas	17.7	0.9	Utah	71.0	51.4
Montana	50.5	41.7	Washington	45.5	21.4
Nebraska	86.4	81.7	Wyoming	85.1	89.9
Nevada	58.9	48.9			

[1] No defined rights in Arkansas or Louisiana.

In the following paragraphs the laws and regulations of the various States (except Arkansas and Louisiana) governing the acquisition and exercise of rights to water for irrigation, are summarized:

Arizona.—The bill of rights of Arizona of 1864 declared all water capable of being used for navigation or irrigation to be public property, and that no person might appropriate water for private use except under legislative authority. The legislature in 1864 also declared all running streams public and applicable to the purposes of irrigation and mining under prescribed regulations.

In 1887 the legislature abolished the common-law doctrine of riparian rights, and the State constitution of 1910 contains a similar provision.

Under an act of 1893, appropriation is by notice posted at the point of diversion and filed with the county recorder.

In 1919 the State adopted a code of water laws, declaring that water from all sources, in natural channels, belongs to the public, and is subject to appropriation and beneficial use under prescribed regulations. The office of State water commissioner was created in this year. The commissioner may, on his own initiative or upon the petition of one or more users of water from any source, examine the source and the works taking water therefrom, make findings of fact and define the respective rights in and to such water, and submit his findings to the superior court of the county in which the greatest number of users reside. The court examines the record and issues its decree defining the water rights in such source.

California.—California adopted the common law of England in 1850 and thereby assumed the doctrine of riparian rights. The first legislation relating to water rights was in 1872, when it was provided that rights to flowing water might be acquired by appropriation for useful or beneficial purposes; that prior appropriations carried prior rights; and that appropriation should be by posting notice at the point of diversion, and filing copy of it in the county records. This law remained in effect until 1913.

The constitution of the State, adopted in 1879, declared the use of all water then and thereafter appropriated to be a public right, subject to the control of the State. The courts, however, continued to recognize riparian rights. (Lux *v.* Haggin, 69 Cal. 255.)

In 1913 a system of public control of the use of water was adopted with a provision that owners of riparian lands must put water to use in order to retain their rights. A section of the act declares all water never appropriated, or appropriated and not used, or not used with due diligence considering the character of the purpose for which appropriated, to be unappropriated; and all waters flowing in natural channels, except so far as they have been or are being appropriated to useful purposes upon land riparian to them, are declared to be public water of the State and subject to appropriation. Further, if any portion of the water of any stream shall not be put to beneficial use upon land riparian to it for a period of 10 consecutive years after the passage of the act, it is conclusively presumed that the use of such water is not needed, and such portion of the water not used and not otherwise appropriated is declared to be subject to appropriation. This declaration has not been passed upon by the courts.

The act of 1913 created a water commission which was, upon application, to find the facts and issue licenses to water users. An amendment in 1917 provided that the findings of the commission should be certified to the courts and affirmed if no exceptions were taken, or affirmed or modified after hearings. After decree of confirmation, the commission issued to the applicant a certificate setting forth his rights as so determined. This amendment of 1917 limited the findings of the commission to rights based on prior appropriation, but in suits transferred by the courts to the commission (now the department of public works), as referee, riparian as well as appropriation rights are determined. By the act of 1917 water not beneficially used for a period of three years for the purposes for which appropriated or adjudicated, reverts to the public and becomes unappropriated.

In 1928 a constitutional amendment was adopted providing that riparian rights should attach to only so much of the flow of a stream as might be required for reasonable and beneficial use. This amendment has been attacked and is before the courts.

Colorado.—The first Territorial Legislature of Colorado, by act of 1861, declared that persons holding lands on the banks or in the neighborhood of streams had the right to use the water for irrigation. It also provided for rights of way for ditches to lands not bordering on such streams. The supreme court held this enactment not to be a recognition of riparian rights, but rather to secure to riparian owners the right to divert water. (Crippen *v.* White, 28 Col. 298.)

The constitution of 1876 declared unappropriated water of every stream to be public property and dedicated such water to the public use, subject to appropriation. The constitution further declared that the right to appropriate the water of any natural stream to beneficial use shall never be denied. Prior appropriations gave prior rights as between those using the water for the same purpose.

In 1879 a law was enacted dividing the State into districts, the division being based on lands irrigated from defined stream systems, and giving the district courts exclusive jurisdiction to define and fix all rights to water. This enactment was superseded in 1881 by an act requiring all claimants of water rights to file statements of their claims with the appropriate clerks of the district courts before June 1, 1881, and providing that after that date claimants in any water district might petition the proper court for an adjudication of all water rights within such district. This was the pioneer step in the definition of water rights by court adjudication, and the law is still in force.

By an act of 1903 and amendments thereto plans for irrigation works must be filed in the office of the State engineer, but this is not an application for permission to appropriate water, as no such permit is required.

Idaho.—The territory of Idaho was organized under the act of March 3, 1863, and the State was admitted to the Union in 1890. In 1881 the Territorial Legislature recognized the right to appropriate water from streams for useful and beneficial purposes, and the method provided was the posting of notice at the point of diversion and filing a copy of the notice in the county records. The State constitution, adopted in 1889, declared that the right to appropriate to beneficial use the unappropriated water of natural streams "shall never be denied."

An act of 1895 retained the provisons of the Territorial law of 1881 and further provided that a duplicate copy of the notice of appropriation must be filed with the State engineer. In 1899 a further enactment also retained these provisions for the filing of notice and provided further that all claimants to water must file statements of their claims within six months after the passage of the act. These provisions remained in force until 1903, when an act was passed requiring the appointment of State officials to distribute water to those entitled to its use and provided for the bringing of suits by these officials to have rights to water adjudicated by the courts. This provision was declared unconstitutional in Bear Lake Co. *v.* Budge, 9 Idaho, 703, but the portion of the law permitting the courts, in their discretion, to request the aid of the State engineer (whose duties have since been transferred to the department of reclamation) was upheld in the Boise City Irrigation & Land

Co. *v.* Stewart, 10 Idaho, 38, 77. Water rights may be adjudicated only in proceedings initiated by claimants to water.

Riparian rights are not recognized in Idaho.

Kansas.—In 1886, Kansas enacted a law declaring that rights to the use of water for irrigation might be acquired by appropriation, and that as between appropriators first in time is first in right. This law required the posting of notice at the point of intended diversion and the filing of a copy with the county clerk.

In 1891 the legislature passed an act declaring that all natural waters of the State west of the ninety-ninth meridian should be devoted first to irrigation in aid of agriculture, subject to domestic use, and secondly, to other industrial purposes; and that such waters might be diverted from their natural locations for these purposes. There was a proviso that no such diversion should interfere with or divest prior vested rights of appropriation for the same or a higher purpose, without due process of condemnation. Natural surface lakes having no outlet were declared to be parcel of the land and under the exclusive control of the proprietor of such land. Subterranean waters were made subject to appropriation in the same manner.

In 1927 a water commission was created by law to work out a plan for complete water development and to prescribe rules and regulations for the appropriation of water. The commission did not function. In 1927 the statutory duties of the commission were transferred to the division of water resources.

The 1886 law, providing for the posting and filing of claims to appropriation, and the 1927 law, providing for commission control of appropriation, are both on the statute books. The 1886 law, however, is the one which is generally followed. Conflicting water rights are adjudicated and defined only in suits between claimants.

Montana.—The first Territorial Legislative Assembly of Montana in 1865 recognized the right of persons holding land bordering on or in the neighborhood of a stream to take water from the stream for irrigation, and provided a method of obtaining rights of way for ditches over the la ıds of others. In 1870 this law was superseded by an act extending the right to take water for irrigation to the holders of land anywhere within the Territory and recognizing priority among users.

In 1885 a more comprehensive law provided for the acquisition of water rights by appropriation for useful or beneficial purposes. This act declared that as between appropriators "first in time is first in right." Persons desiring to appropriate water were required to post notices of their claims and to file copies with the county recorders. Those who had acquired rights prior to the passage of this act were also required to file declarations of their claims with the county recorders. Controversies regarding water rights were referred to the courts. This law is still in effect. The State never has provided for applications for permits to appropriate water.

The constitution of 1889 declared the use of all water then or thereafter appropriated for beneficial use, and the use of necessary rights of way over the lands of others for channels and reservoirs, to be a public use. Doubt as to the application of the doctrine of riparian rights was removed by the declaration of the supreme court of the State in 1921, in the case of Mettler *v.* Ames Realty Co., 61 Montana, 152; 201 Pacific, 702, where it was held: "The common-law doctrine of riparian rights has never prevailed in Montana since the enactment of the Bannack Statutes in 1865."

Nebraska.—Nebraska, upon its organization, adopted the common law of England so far as not in conflict with existing laws and acts of the legislature. The supreme court of the State held that this was an adoption of the common-law doctrine of riparian rights.

In 1889 the legislature enacted a law permitting the acquisition of water rights by appropriation for beneficial use. In the case of Crawford Co. *v.* Hathaway, 93 Northwestern, 781, the Supreme Court held that this act abrogated the doctrine of riparian rights except as to those rights which had already accrued. This law required the posting and filing of notice of intended diversions, but required no filing or declarations of claims already acquired.

In 1895 a State board of irrigation was created and water rights were thereafter to be acquired by filing applications for permits to appropriate water and proof of the completion of work in accordance with such permits. The board issued certificates defining the rights acquired. This board was given power to adjudicate rights to water under its own procedure.

In 1919 the functions of the board of irrigation were transferred to a department of public works, without change in the general system for the acquisition of water rights.

Nevada.—In 1886 the legislature enacted a law requiring any person desiring to construct a ditch or flume to make a certificate describing it before some officer competent to take acknowledgments of deeds and to have the certificate recorded in the office of the county recorder.

In 1889 a law was enacted which was designed to provide for the recording and administration of water rights by the district courts. All claimants to interests in irrigation works were required to file statements of their claims before September 1, 1889, with the proper county recorder, and parties desiring to build any works or extend works already constructed were required to file similar statements. Exclusive jurisdiction over water rights was given to the district courts and they issued certificates to holders of such rights. Provision was made for the appointment of commissioners to distribute the water in accordance with court orders. This act was repealed in 1893, but many filings were made after that date.

A new law in 1899 declared the water of all natural streams and lakes, not held in private ownership, to belong to the State and to be subject to its control. Applications to appropriate water were to be made to a board consisting of the county commissioners and the county surveyor in the separate counties. There was a special prohibition against issuing permits for water unless there were a surplus in the source of supply, over and above existing vested and accrued rights. It was in the discretion of the county board to decide whether the county would avail itself of this act, and it was not generally put into effect. In 1903, an additional law made the use of water a public use and created the office of State engineer and charged this officer with the duty of preparing a list of all water appropriations, according to priority, for each stream in the State, and of issuing certificates defining water rights. This law was later reenacted in such way that the findings of the engineer were submitted to the district court and the court by decree defined the respective rights of claimants.

In 1905 this law was further extended by new sections requiring application to the State engineer for permit to appropriate water and submission of proof of completion of work in accordance with the permit before certificates of water rights would be issued.

This law was twice repealed and reenacted in substance, in 1907 and 1913, respectively, and the 1913 act providing this general system for the acquisition of water rights is still in force.

Riparian rights are not recognized in Nevada.

New Mexico.—New Mexico was organized as a Territory in 1850, and the first legislature passed an act declaring that all the inhabitants of the Territory should have the right to construct either private or common acequias and take water wherever available.

A law of 1891 made the filing of a description of all works built a condition precedent to the attaching of water rights. In 1905 a comprehensive water law was passed declaring that all water belonged to the public and placing the supervision of public waters under a Territorial engineer, but the law never became operative because of failure to provide funds for its administration.

In 1907 the act of 1905 was repealed and a new law enacted providing for the adjudication of water rights in the courts, upon information collected by the Territorial engineer. The attorney general was authorized to initiate suits to define water rights. The method of acquisition provided was: Application to the engineer for a permit to appropriate and proof of the completion of the work and use of the water in accordance with the terms of the permit. Upon satisfactory compliance with these requirements, the engineer issues licenses defining the rights acquired. This law is still in force.

New Mexico was admitted as a State in 1911 and the constitution adopted at that time (Article XVIII) recognized and confirmed all existing water rights and declared that all unappropriated water belonged to the public and was subject to appropriation for beneficial use in accordance with the laws of the State. Priority of appropriation gave the better right. The constitution declared that "beneficial use shall be the basis, the measure, and the limit of the right to the use of water."

The doctrine of riparian rights has been wholly superseded in New Mexico. (Hagerman Irrigation Co. *v.* McMurray, 16 N. M. 172; 115 Pac. 823.)

North Dakota.—In 1881 the Territorial Legislature of Dakota passed an act declaring generally that persons holding titles to lands within the Territory were entitled to the usual enjoyment of the waters of its streams for agricultural and other purposes, provided the right to such use should not interfere with any prior right in regard to which the law had been complied with. This act provided methods of securing rights of way over lands between streams and places of use and required the posting of notice of intended appropriation.

North Dakota was organized from a part of the Dakota Territory and admitted as a State in 1889, and the constitution of the State declared that the waters in all natural watercourses were forever the property of the State for mining, irrigation, and manufacturing purposes. In 1899 the State legislature reenacted the Territorial law of 1881 in substantially the same language. In 1905 the State adopted a code covering water rights, which contains the provision that all waters within the State, from all sources of water supply, belong to the public and, except as to navigable waters, are subject to appropriation for beneficial use. (Laws of 1905, ch. 34.)

Under the code water rights are acquired by application to the State engineer for permit to appropriate. When the works are completed the engineer issues a certificate of completion, and when water has been put to beneficial use a license is issued defining the right. The code also provides for complete adjudication of all rights to water by means of a hydrographic survey of all streams by the State engineer and the bringing of action on behalf of the State by the attorney general to determine all rights to the use of such water.

Oklahoma.—The Territorial Legislature of Oklahoma in 1897 enacted the first law relating to water rights, in which it declared unappropriated water of natural watercourses within those portions of the State where irrigation is beneficial to agriculture to be the property of the public and subject to appropriation. This law contained a recognition of riparian rights in a proviso that the flow or underflow of water should not be diverted to the prejudice of the riparian owner, without his consent, except after condemnation proceedings. It was provided that claims should be filed with the county recorders of deeds for both existing and future rights.

In 1905 the office of Territorial engineer was created, and it was provided by law that the acquisition of water rights should be upon application to the engineer for permit. The law provided for submission of proof of completion of the works and proof of beneficial use of the water before the issuance of licenses defining the right. The State engineer is also required to make surveys and collect necessary information for defining rights to water and to transmit such information to the attorney general who, on behalf of the State, brings suit for the adjudication of such rights. The attorney general also intervenes in suits between other parties, and the courts are directed to call on the State engineer for information in suits involving water rights. The duties of the State engineer have now been transferred to the State conservation commission.

Oregon.—The first legislation in Oregon on the subject of water rights was enacted in 1891 and contained the general declaration that all existing appropriations of water for beneficial use, made in accordance with law or established custom or regulation, should be respected and upheld to the extent of the amount of water actually appropriated. It was also provided that in a suit regarding water rights all persons taking water from the same source might be made parties to the end that all rights might be defined in one action.

An act of 1905 created the office of State engineer and provided that subsequent appropriators should post notice and file duplicates with the county clerk and the State engineer. Special provisions were made for appropriation by the United States and for participation by the State engineer in adjudications under the United States Reclamation Act.

In 1909 a new water code was adopted. A State board of control was given jurisdiction over the water of the State. This board consisted of the State engineer and the superintendents of the two water divisions into which the State was divided. It was provided that appropriation should be by application to the State engineer for a permit and when rights had been perfected in accordance with the permit, proof was submitted to the board of control and certificate issued by it defining the rights acquired. Under a new procedure for adjudicating rights provided in this law the engineer and the superintendent of the division in which the source is located collected information, made surveys, and prepared findings of fact and an order defining the right. These data were filed with the court. After proper hearing, the court issued its decree fixing all rights. Certificates were then issued by the board in accordance with the court's decree. This procedure is still in effect, although the administrative functions have been somewhat changed and are now centered in the State engineer.

In 1927 an act was passed providing for the appropriation of underground waters in counties east of the Cascade summit under the same procedure adopted for surface waters.

Riparian rights, though recognized to some extent, have been considerably restricted in their scope by legislation and court decisions. The provisions of the 1909 act defining and limiting vested riparian rights "to the extent of the actual application to beneficial use" has been upheld in Re Water Rights of Hood River, 114 Oregon 112; 227 Pac. 1065.

South Dakota.—South Dakota was organized from part of the Dakota Territory and admitted as a State in 1889. The annotated statutes of 1899 carried over the Territorial law of Dakota of 1881 declaring unappropriated water of natural watercourses, within those portions of the State where irrigation is beneficial to agriculture, to be the property of the public and subject to appropriation. This law recognized riparian rights by providing that water should not be diverted without the consent of the riparian owner, except upon condemnation proceedings.

It was also provided that claims to water rights should be filed with the county recorders for both existing and future rights.

In 1905 South Dakota adopted a new water law providing that all water from all sources of supply, not navigable, belonged to the public and was subject to appropriation for beneficial use. It created the office of State engineer; provided that parties wishing to acquire rights must apply to the engineer for permits to appropriate water; required the submission of proof of completion of works before the issuance of certificates of construction; and made proof of use necessary before licenses were issued defining the rights acquired.

It was also provided that the State engineer should make surveys and collect the necessary information for the adjudication of rights secured prior to the passage of the act; that upon the advice of the engineer the attorney general should intervene in suits relating to water rights or initiate such suits; and that when suits were brought the courts should call upon the engineer to make surveys of the streams in question at the expense of the litigants.

The Supreme Court of South Dakota, in the case of St. Jermain Irrigation Ditch Co. *v.* Hawthorne Ditch Co., 32 S. D. 260, held those sections of this law which interfered with vested riparian rights, and which directed intervention by the State engineer at the expense of the litigants to be unconstitutional.

Under this decision riparian rights appear to be paramount in South Dakota.

Texas.—Without any formal declaration of the right to take water from the streams of the State, the Legislature of Texas in 1852 and subsequently recognized this right by providing for the control of ditches by the commissioners' courts and by granting rights to chartered companies to take water from certain streams.

The first general declaration of the legislature in regard to water rights was in 1889 when an act was passed declaring that the unappropriated water of every natural watercourse in the arid portions of the State where irrigation was necessary might be diverted for irrigation and other beneficial uses, but with a proviso that such water should not be diverted so as to deprive any riparian owner of the use of water for domestic purposes. Such water was declared to be the property of the public and subject to appropriation. All persons having previously appropriated water and those seeking to appropriate in the future were required to file statements of their claims with the county clerks. This law as reenacted in 1895 provided that water might not be diverted from its natural course to the detriment of riparian owners, without their consent, except after condemnation.

In 1913 further legislation extended the right of appropriation to the entire State and placed the supervision of water under a State board of water engineers. Parties claiming rights were required to file statements thereof with the board, and those desiring to appropriate must apply to the board for permits. The original law did not give the board authority to define rights acquired prior to the creation of the board, and a statute of 1917, purporting to give such authority was declared unconstitutional in Board of Water Commissioners et al. *v.* McKnight, 111 Texas 82; 229 S. W. 301.

Riparian rights are recognized in Texas only as they relate to the "ordinary flow and underflow of the stream." (Mott et al. *v.* Boyd, 116 Texas 82; 286 S. W. 458.)

Utah.—The organic act of the Territory of Utah of 1850 did not mention irrigation, but the Territorial legislature disposed of water rights by direct grant and delegated this authority to the county courts of the several counties. Many such grants were made by both the legislature and the county courts.

The act of 1880 provided for recording vested rights to the use of water and for the regulation of the exercise of such rights. The county selectmen were made water commissioners for their respective counties and were empowered to determine all claims to the use of water and to issue certificates therefor. No suits could be maintained in the courts until the water commissioners had acted, but appeal might be taken to the courts.

The constitution of Utah, adopted in 1896, declared that all existing rights to water for useful or beneficial purposes were

recognized and confirmed. In the next year the legislature enacted a law providing that appropriators should post notice at the point of diversion and in the nearest post office and file copy thereof in the county records.

In 1903 it was provided by a law of that year that parties wishing to appropriate water should first secure permits from the State engineer and after the completion of the works and the use of water in accordance with the terms of the permits the engineer should issue certificates defining the rights acquired.

The same act made it a duty of the State engineer to make surveys and collect information with regard to water rights and submit reports thereon to the appropriate district courts. The courts, in turn, determined and defined the rights on the basis of the engineer's reports and any testimony taken. This law has been reenacted and the procedure somewhat changed, but the State engineer is still required to formulate proposed determinations for the guidance of the courts in entering final decrees. Many rights have been adjudicated in ordinary suits between claimants, but under the present law the services of the State engineer are utilized by the court.

Riparian rights are not recognized in Utah.

Washington.—No general legislation relating to irrigation was enacted during the Territorial existence of Washington, but upon its admission to the Union in 1889 the constitution of the State declared the use of the waters of the State for irrigation, mining, and manufacturing to be a public use. (Article XXI.)

The first legislature enacted a law requiring parties claiming any rights to water for irrigation to file sworn statements of their claims with the clerks of the district courts by June 1, 1890, and those thereafter desiring to appropriate water were required to file a similar statement, together with a map showing the claim. It was also provided that interested parties might apply to the superior courts of the respective counties to have the rights to water from any source adjudicated, and the courts were required to proceed with such adjudication if deemed practicable. This first act provided also that riparian owners were entitled to use water not otherwise appropriated for purposes of irrigation to the "full extent of the soil for agricultural purposes," and that riparian rights might be condemned.

In 1891 an additional act required appropriators to post notice and file copy of it with the county auditor. This act remained in effect until March 14, 1917, when a further enactment required that parties desiring to acquire water rights must make application to the State hydraulic engineer for a permit. The duties of this official have since been transferred to the director of conservation and development. Riparian rights in navigable waters are not recognized in Washington. (State ex rel. Ham, Yearsley and Ryrie *v.* Superior Court of Grant County, 70 Washington 442; 126 Pac. 945.) Riparian rights in nonnavigable streams are limited to the amount of water which can be beneficially used, either directly or prospectively, within a reasonable time or in connection with riparian lands. (Brown et ux. *v.* Chase, 125 Washington 542; 217 Pac. 23.)

Wyoming.—Wyoming was organized as a Territory in 1868; and while the first Territorial legislature adopted the common law of England, so far as it was "not inapplicable," the supreme court later decided that this enactment did not establish the doctrine of riparian rights in Wyoming. (Mayer *v.* Preston, 6 Wyoming, 308.) In 1875 a Territorial law provided that persons holding land along streams were entitled to use the water for irrigation and to have rights of way for canals over intervening lands.

Another territorial law of 1886 placed the jurisdiction over waters in the district courts and provided for an adjudication by them of priority of right in water from any source. The law also declared the unappropriated water of the territory to be the property of the public, dedicated to the use of the people, and subject to appropriation.

When Wyoming was admitted to the Union in 1890 the constitution contained general declarations regarding water to the effect that all water in natural channels or reservoirs, not appropriated, was the property of the State; that prior appropriation gave prior right; and that no appropriation should be denied unless the denial be demanded by the public interest. The administration of the water of the State was placed in the hands of the State engineer as the head of the board of control. The first State legislature enacted the necessary laws to carry out the constitutional provisions, and the system then adopted remains in effect. Those persons desiring water rights make applications to the State engineer for permits, and upon proof of completion and use in accordance with the terms of the permits the board of control issues certificates defining the rights acquired. The board also adjudicates rights previously acquired and issues certificates in accordance with its decisions. This law of 1890 has been upheld by the supreme court of the State.

INVESTMENT IN ENTERPRISES AND COST OF MAINTENANCE AND OPERATION

Investment in irrigation enterprises is shown in the United States Summary and in the State reports in classifications identical with those applied to the area irrigated, except as regards water rights. Table 25 shows the total investment and the average investment per acre in 1930 and 1920, and increase for this decade, by States.

TABLE 25.—INVESTMENT IN IRRIGATION ENTERPRISES, BY STATES: 1930 AND 1920

STATE	INVESTMENT				INCREASE,[1] 1920–1930	
	Total		Average, per acre		Total	Average, per acre
	1930	1920	1930	1920		
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Total (19 States)	1,032,755,790	697,657,328	39.57	26.81	335,098,462	12.76
Arizona	73,328,197	33,498,094	88.97	53.40	39,830,103	35.57
Arkansas	6,836,648	7,183,322	32.56	40.13	−346,674	−7.57
California	450,967,979	194,886,388	66.17	33.06	256,081,591	33.11
Colorado	87,603,240	88,302,442	21.48	22.90	−699,202	−1.42
Idaho	84,500,354	91,501,009	32.29	29.59	−7,000,655	2.70
Kansas	1,685,052	2,007,381	20.17	30.47	−381,729	−10.30
Louisiana	15,744,743	14,063,181	19.80	19.30	1,681,562	0.50
Montana	50,319,204	52,143,363	22.11	18.94	−1,824,159	3.17
Nebraska	21,386,319	13,909,185	30.39	24.73	7,477,134	5.66
Nevada	15,457,931	14,754,280	21.00	20.94	703,651	0.06
New Mexico	19,834,380	18,210,412	30.20	26.16	1,623,968	4.04
North Dakota	1,267,314	1,857,118	52.79	54.25	−589,804	−1.46
Oklahoma	160,099	151,325	21.84	15.65	8,774	6.19
Oregon	38,754,548	28,929,151	33.46	21.52	9,825,397	11.94
South Dakota	4,502,117	5,465,248	41.10	36.21	−963,131	4.89
Texas	49,022,164	35,072,739	41.64	30.48	13,949,425	11.16
Utah	35,669,819	32,037,351	23.13	18.84	3,632,468	4.28
Washington	40,561,895	29,299,011	64.23	45.98	11,262,884	18.25
Wyoming	35,153,187	34,326,328	21.24	18.75	826,859	2.49

[1] A minus sign (−) denotes decrease.

Notwithstanding the smallness of the increases in area irrigated and area enterprises were capable of supplying with water, the investment in irrigation enterprises during the decade increased by almost half (48 per cent), this being attributable partly to heavy expenditures made on a few large enterprises which are not in full service, and, to a greater degree, to the provision of storage works and supplemental pumping plants which have effected an improvement in the water supply for numerous areas, large in total, which had previously been reported under irrigation. Likewise, the modernizing of pumping plants and the deepening of wells previously reported, has involved additional investments, also large in total, in many sections, without involving corresponding increases in areas. Many of these improvements were brought about at costs materially higher than those represented by works built in earlier decades, and this fact has had a tendency to make present owners of such earlier works estimate costs higher than they would had recent prices been lower. Moreover, the bringing of water to land becomes increasingly difficult; the easily constructed projects are carried out first, leaving the more difficult ones to be developed when favorable economic conditions or prospects appear to justify them.

The average investment per acre, shown in Table 25, is based upon the areas to which enterprises reported themselves capable of supplying water in the census

year, rather than the areas actually irrigated in the preceding season. Averages based on the latter area would be somewhat higher than those shown.

More than three-fourths (77 per cent) of the net increase in investment is reported by California, where much of the recent pumping development has taken place. Arizona, Nebraska, Oregon, Texas, and Washington, which account for most of the remainder, have also experienced a notable increase in pumping. The importance of pumping as a phase of recent irrigation development is more fully discussed in the section beginning on page 34.

Statistics shown in Table 25 are repeated in Table 26, by principal drainage basins.

TABLE 26.—INVESTMENT IN IRRIGATION ENTERPRISES, BY PRINCIPAL DRAINAGE BASINS: 1930 AND 1920

DRAINAGE BASIN	INVESTMENT				INCREASE,[1] 1920–1930	
	Total		Average, per acre		Total	Average, per acre
	1930	1920	1930	1920		
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Total	1,032,755,790	697,657,328	39.57	26.81	335,098,462	12.76
Red River (of the North) tributaries	20,925		9.97		20,925	9.97
Missouri River and tributaries	136,506,721	131,553,106	24.95	22.66	4,953,615	2.29
Mississippi River and tributaries, exclusive of Missouri River	31,831,673	35,183,789	27.19	30.53	−3,352,116	−3.34
Gulf streams other than Mississippi River and Rio Grande	28,578,193	29,439,808	23.39	25.43	−861,615	−2.04
Rio Grande and tributaries [2]	52,979,214	33,885,580	29.32	17.95	19,093,634	11.37
Independent streams in Rio Grande Drainage Basin	769,394	938,531	7.15	34.95	−169,137	−27.80
Colorado River and tributaries	132,350,247	86,696,940	39.67	29.03	45,653,307	10.64
Whitewater Draw and tributaries	230,606	299,368	48.52	30.09	−68,762	18.43
Great Basin Drainage	72,068,281	66,589,376	27.94	23.20	5,478,905	4.74
Columbia River and tributaries	157,355,114	145,672,382	37.10	29.32	11,682,732	7.78
Pacific Ocean streams other than Colorado and Columbia Rivers	420,065,422	167,308,448	68.20	32.47	252,666,974	35.73

[1] A minus sign (−) denotes decrease.

[2] Not including "Independent streams in Rio Grande Drainage Basin."

Areas in the drainage basins of Pacific Ocean streams other than Colorado and Columbia Rivers account for 75 per cent of the total increase. The investment per acre for these areas is the highest shown. These basins, with a few exceptions, are located in California.

The investment in irrigation enterprises and the average investment per acre, based on the area enterprises were capable of irrigating, distributed according to the sources from which water is received, are shown on page 54. The area enterprises were capable of supplying with water, classified in the same way, is shown on page 50. The distribution of the areas enterprises were capable of supplying with water and the investment, by the sources from which water is received, are shown in percentages, in Table 27, together with the average investment per acre. The table also shows a comparison of the average for each class with the general average.

TABLE 27.—PROPORTIONATE DISTRIBUTION OF AREAS ENTERPRISES WERE CAPABLE OF SUPPLYING WITH WATER, AND INVESTMENT, BY SOURCE OF WATER SUPPLY: 1930 AND 1920

SOURCE OF SUPPLY	PROPORTION OF TOTAL				AVERAGE PER ACRE			
	Area enterprises were capable of supplying with water		Investment in irrigation enterprises		Investment		Ratio to general average	
	1930	1920	1930	1920	1930	1920	1930	1920
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Dollars*	*Dollars*	*Per cent*	*Per cent*
Total	100.0	100.0	100.0	100.0	39.57	26.81	100.0	100.0
Streams, gravity	65.5	74.0	43.8	63.0	26.44	22.78	66.8	85.1
Streams, pumped	10.4	8.1	9.9	8.5	37.67	27.97	95.2	104.5
Streams, gravity and pumped	1.7	0.9	2.0	1.4	47.63	39.57	120.4	149.3
Wells, pumped	9.4	6.4	26.3	11.0	110.07	45.82	278.2	171.1
Wells, flowing	0.2	0.3	0.2	0.4	42.27	36.88	106.8	137.7
Wells, pumped and flowing	(1)	0.2	0.1	0.4	74.58	58.47	188.5	218.2
Lakes, pumped	0.5	0.2	0.3	0.3	26.43	37.84	66.8	142.0
Lakes, gravity	0.5	0.6	0.5	0.4	35.61	19.41	90.0	72.6
Springs	1.0	1.0	0.3	0.8	13.27	22.96	33.5	85.8
Stored storm water	0.2	0.9	0.2	2.2	28.31	67.47	71.5	251.7
City water	(1)	(1)	(1)	(1)	17.86	156.88	45.1	585.2
Sewage	(1)	(1)	(1)	(1)	65.35	52.85	165.2	197.1
Streams, gravity and wells, pumped	5.8	1.5	9.7	4.1	66.29	72.71	167.5	271.1
Streams, gravity and wells, flowing	0.1	0.4	0.1	0.4	16.89	27.37	42.7	102.1
Other mixed	4.4	5.4	5.5	6.9	49.82	35.25	125.9	129.3
Other and not reported	0.1	0.1	(1)	0.1	20.18	54.89	51.0	204.6
Supplemental from—								
Pumped streams	[2] 0.1		0.1		28.28		71.5	
Pumped wells	[2] 1.2		0.9		29.92		75.6	
Flowing wells	(1)		(1)		24.31		61.4	

[1] Less than one-tenth of 1 per cent.

[2] Not considered in total because included in enterprises reporting other sources of supply listed above.

As is the case with area irrigated, "streams, gravity" is by far the most important class in area enterprises were capable of supplying with water and in investment. "Wells, pumped;" "streams, pumped;" "streams, gravity and wells, pumped;" and "other mixed" are other classes reporting conspicuously high proportions of both area and investment. "Other mixed" includes some investments involving pumping, which are taken into account in Table 37, page 39. "Streams, gravity" is less important when measured by the investment than by area because it includes the bulk of the early, easily constructed systems. The average investment per acre for this group is one-third less than the average representing all groups. On the other hand, the average representing "wells, pumped" is the highest in the 1930 list, and nearly three times (278 per cent) the general average.

Although constituting a heavy additional investment for lands supplied from other sources, the average investment per acre shown for each of the three "supplemental" classes is somewhat less than the general average.

The cost of maintenance and operation and the average cost per acre, classified by the sources from which water is received, are shown in Table 11, page 54. The average cost per acre and a comparison for each source with the general average are shown in Table 28.

TABLE 28.—PROPORTIONATE DISTRIBUTION OF COST OF MAINTENANCE AND OPERATION, BY SOURCE OF WATER SUPPLY: 1929 AND 1919

SOURCE OF SUPPLY	Proportion of total irrigated area for which cost is reported		AVERAGE, PER ACRE			
			1929		1919	
	1929	1919	Amount	Ratio to general average	Amount	Ratio to general average
	Per cent	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*
Total	100.0	100.0	2.77	100.0	2.43	100.0
Streams, gravity	66.3	75.0	1.21	43.7	1.25	51.4
Streams, pumped	9.0	7.1	4.30	155.2	6.50	267.5
Streams, gravity and pumped	1.4	1.2	4.41	159.2	2.33	95.9
Wells, pumped	10.3	6.5	9.17	331.0	10.07	414.4
Wells, flowing	0.1	0.2	2.34	84.5	2.77	114.0
Wells, pumped and flowing	(1)	0.2	9.27	334.7	8.04	330.9
Lakes, pumped	0.4	0.3	3.93	141.9	5.20	214.0
Lakes, gravity	0.3	0.5	2.70	97.5	1.30	53.5
Springs	1.0	0.9	1.02	36.8	1.63	67.1
Stored storm water	0.2	0.5	1.31	47.3	2.39	98.4
City water	(1)	(1)	7.31	263.9	20.73	853.1
Sewage	(1)	(1)	2.16	78.0	9.05	372.4
Streams, gravity and wells, pumped	6.2	1.9	4.46	161.0	5.97	245.7
Streams gravity and wells, flowing	0.1	0.5	2.52	91.0	1.36	56.0
Other mixed	4.5	5.2	3.52	127.1	2.71	111.5
Other	(1)	0.1	1.58	57.0	10.75	442.4
Not reported	(1)		2.46	88.8		
Supplemental from—						
Pumped streams	(2)	(2)	6.27	226.4	(3)	(3)
Pumped wells	(2)	(2)	5.91	213.4	(3)	(3)
Flowing wells	(2)	(2)	0.61	22.0	(3)	(3)

[1] Less than one-tenth of 1 per cent.
[2] Not considered in total because included in enterprises reporting other sources of supply listed above.
[3] Not reported.

Disregarding "city water" because of the small acreage represented, and "other mixed" because of its indefiniteness, the average 1929 cost per acre for every class which does not include pumping, is below the general average cost, while the average for each of the classes involving pumping is somewhat above the general average. Table 27 shows that the average first cost of a water supply from pumped wells is more than four times that of a gravity supply from streams, while Table 28 shows that the average cost of maintenance and operation for "wells, pumped" is nearly eight times that for "streams, gravity," while the latter average is only three-tenths the figure for "streams, pumped." The low cost of a gravity supply from streams as compared with a pumped supply is accounted for largely by the fact that "streams, gravity" includes most of the early inexpensive ditches, the cost of maintenance and operation of which is very low.

COST OF PREPARING LAND

The preparation of land to receive water usually involves the removal of native vegetation, rocks and bowlders; its careful grading and leveling; and the building of small distributing ditches with their gates and other structures. Occasionally, as in the case of an enterprise planning the sale of land and water, this work is done by it in advance of the sale; but such improvement work is usually done by the farmers and at their own expense. The cost represented is additional to the "investment in irrigation enterprises."

Accurate figures on cost of preparing land are seldom obtainable, since the work often is done concurrently with other farm-improvement labors and without the keeping of accounts. Figures obtained from large enterprises were reported in the Fourteenth Census in connection with their statements of lands available for settlement. In the Fifteenth Census the question was made to apply to all enterprises, with the result that a total area equivalent to about 72 per cent of the area all enterprises were capable of supplying with water was represented by estimates of cost per acre. The areas reporting and the estimated costs reported are shown, by States, in Table 29.

TABLE 29.—ESTIMATED COST OF PREPARING LAND FOR IRRIGATION, BY STATES, 1930

STATE	Area reporting cost	ESTIMATED COST REPORTED	
		Total	Average, per acre
	Acres	*Dollars*	*Dollars*
Total (19 States)	18,579,542	524,046,596	28.21
Arizona	495,920	18,903,670	38.12
Arkansas	156,073	1,613,754	10.34
California	4,800,350	220,320,734	45.90
Colorado	2,326,239	48,379,232	20.80
Idaho	2,111,819	49,382,880	23.62
Kansas	60,041	657,980	10.96
Louisiana	482,629	2,732,698	5.66
Montana	1,636,771	16,589,617	10.14
Nebraska	473,213	4,637,353	9.80
Nevada	634,005	20,876,751	32.93
New Mexico	424,115	10,010,087	23.60
North Dakota	21,912	326,095	14.88
Oklahoma	6,036	61,900	10.26
Oregon	949,302	25,907,020	27.29
South Dakota	88,948	1,917,517	21.56
Texas	908,182	29,016,848	31.95
Utah	1,129,338	23,786,844	21.06
Washington	522,773	29,923,695	57.24
Wyoming	1,351,876	18,501,921	13.69

As shown in Table 29, the highest cost of preparing land, per acre, is reported by the State of Washington, with California second, and Arizona third, while the lowest cost is that shown for Louisiana. Costs in the three States first named are influenced by the high value of water and the type of irrigation practiced, which frequently necessitate costly refinements in clearing, grading, and leveling not so necessary in preparing for the irrigation of rice.

COST OF WATER TO FARMERS

The irrigation schedule used in 1930 in the canvass of the enterprises serving more than four farms each contained inquiries on the cost of water to farmers. As these questions had principal application to the affairs of irrigation districts, commercial, and Carey Act companies, a few of the city, State, and Federal Government projects, and the larger cooperative companies, answers were not received from many small enterprises which made their returns on this schedule. Some of the questions were misunderstood, moreover, by enterprises to which they had application, with the result that either they were not answered or were answered with obvious incorrectness. The statistics in the last five columns of Table 30 are, therefore, not complete and are shown only because they appear to represent minima of more or less general significance.

Table 30 repeats the statistics on cost of maintenance and operation which appear in other tables. These were obtained from individual, partnership, and other enterprises of small size, as well as from the large enterprises referred to in the preceding paragraph. Averages in the second column of the table are therefore not strictly comparable with those in columns 4 and 6. The "assessments per acre" shown in columns 4 and 6 include the costs of maintenance and operation of the works of the irrigation enterprises reporting, and in addition, those expenses involved in principal and interest payments on bonds, certificates of indebtedness, notes, and warrants, and for other special purposes. Thus, although for some States the annual assessment shows lower than the cost of maintenance and operation because the reporting enterprises are not identical; for all the States as a group the annual assessment exceeds the cost of maintenance and operation by 65 cents per acre, or 23.5 per cent.

The average assessment of enterprises in arrears in payment of principal or interest obligations on January 1, 1932, appears as 12 cents less than that of all enterprises reporting the item, but the comparison for Colorado, Idaho, Montana, Nebraska, New Mexico, Oregon, Utah, and Washington shows averages generally higher, and in some cases notably so, for the enterprises reporting arrearages. The total irrigable area of these enterprises is 1,773,037 acres.

The final column of the table shows the area subject to annual assessments by irrigation enterprises in 1929, which used no water in that year. Enterprises of various other types engaged in the development of new lands commonly assess the entire irrigable area or those tracts to which they are capable of supplying water, although some such lands make no use of the water. Thus, in addition to the total area irrigated, 1,830,711 acres are reported as assessed for irrigation costs in 1929.

TABLE 30.—AVERAGE COST OF MAINTENANCE AND OPERATION, ANNUAL ASSESSMENTS, AND ARREARAGES OF IRRIGATION ENTERPRISES, BY STATES, 1929

STATE	Area irrigated which reported cost of maintenance and operation	Average cost, per acre	Area irrigated which reported annual assessments	Average assessment, per acre	Area irrigated, 1929, by enterprises which reported principal or interest payment arrears, Jan. 1, 1930	Average assessment, per acre	Area subject to annual assessment, which used no water
	Acres	*Dollars*	*Acres*	*Dollars*	*Acres*	*Dollars*	*Acres*
Total (19 States)	18,690,184	2.77	9,298,401	3.42	816,506	3.30	1,830,711
Arizona	561,605	4.57	402,300	4.82	54,845	3.88	29,706
Arkansas	147,921	7.03					
California	4,538,579	6.10	2,358,390	5.42	136,603	4.61	770,731
Colorado	3,235,629	0.85	1,410,848	1.62	120,603	2.71	132,949
Idaho	2,109,087	1.44	1,485,482	1.95	79,625	3.00	137,615
Kansas	64,983	1.52	31,500	0.81			
Louisiana	431,337	4.09	168,656	7.87	6,950	5.94	12,467
Montana	1,476,854	0.87	323,171	1.79	40,520	4.48	148,567
Nebraska	524,260	1.54	394,138	1.76	61,499	2.24	61,330
Nevada	474,422	0.91	156,990	1.57	6,138	1.25	47,141
New Mexico	493,229	2.15	238,662	3.97	16,980	4.11	18,365
North Dakota	8,773	1.97	6,089	1.50			
Oklahoma	935	7.62					
Oregon	863,685	1.41	385,161	3.51	130,282	4.25	98,708
South Dakota	65,783	1.33	38,659	1.54			26,000
Texas	772,160	4.74	565,791	5.83	1,410	3.16	101,315
Utah	1,301,098	1.00	845,399	1.26	143,507	1.31	72,150
Washington	487,977	4.14	343,718	6.17	14,114	6.56	49,225
Wyoming	1,131,867	0.84	143,447	1.31	3,480	0.76	124,352

IRRIGATION WORKS

The Summary for the United States and the reports for the several States, show for 1930 the distribution of irrigation works by date of beginning of enterprises, by character of enterprise, and by drainage basin. In the tables following (Tables 31 to 35, inclusive) the totals for the various types of works, except those pertaining to pumping, are grouped by States, with comparative figures from the census of 1920. Data for pumping equipment are grouped in a section on pumping beginning on page 34.

Table 31 shows number of diversion dams and storage dams reported in 1930 and 1920; and a classification of the dams reported in 1930, by type of material. The group of "other and mixed" diversion dams includes many dams of temporary character, such as those made of bowlders and brush, which are renewed annually or oftener. Most dams in the other classifications represent permanent construction.

Oregon has a larger number of diversion dams than any other State. Colorado is second in number of diversion dams and first in storage dams, California

being second in the latter category. Montana is third in both groupings.

Of the permanent types of diversion dams (ignoring the "other and mixed" group), timber dams are the most numerous, and earth-and-rock dams comprise approximately 58 per cent of all storage dams.

Statistics on number of diversion dams collected in the census of 1920 were not identified by material.

TABLE 31.—DAMS, 1930 AND 1920, BY MATERIAL, 1930, BY STATES

STATE	DIVERSION						STORAGE					
	Total		Material, 1930				Total		Material, 1930			
	1930	1920	Concrete or masonry	Timber	Other and mixed [1]	Not reported	1930	1920	Concrete or masonry	Earth and rock	Other and mixed	Not reported
Total (19 States)	*Number* 21,947	*Number* 23,894	*Number* 2,380	*Number* 3,077	*Number* 15,687	*Number* 803	*Number* 2,949	*Number* 3,931	*Number* 362	*Number* 1,713	*Number* 718	*Number* 156
Arizona	267	248	34	4	197	32	78	99	9	57	4	8
Arkansas	1	63		1			6	17		6		
California	1,654	2,070	319	265	1,025	45	421	455	98	156	143	24
Colorado	3,672	3,647	273	742	2,506	151	706	803	16	523	136	31
Idaho	2,305	2,872	205	227	1,836	37	152	288	22	80	47	3
Kansas	27	10	14	3	9	1	7	13	2	3	1	1
Louisiana	36	419	1		34	1	81	63		69	10	2
Montana	2,856	3,545	188	472	1,990	206	326	523	40	176	86	24
Nebraska	185	260	61	18	102	4	28	73	3	20	3	2
Nevada	1,640	1,523	132	148	1,321	39	118	82	20	71	22	5
New Mexico	665	1,423	56	59	525	25	69	153	12	29	23	5
North Dakota	9	26	1		8		10	11	2	8		
Oklahoma	4	7			4		3	3	2	1		
Oregon	3,806	3,285	422	529	2,754	101	167	309	24	61	73	9
South Dakota	91	207	3	4	43	41	10	182		9		1
Texas	107	165	43	4	55	5	108	134	60	75	14	19
Utah	1,717	1,479	314	135	1,237	31	287	307	19	180	81	7
Washington	499	579	101	149	217	32	100	115	11	52	30	7
Wyoming	2,406	2,066	213	317	1,824	52	212	301	22	137	45	8

[1] Principally temporary dams, replaced annually.

Table 32 shows the number and capacity of reservoirs reported in 1930 and 1920. The number includes small farm reservoirs accessory to pumping plants, which usually store only a few acre-feet of water for short periods; included also, however, are reservoirs of capacities ranging up to 1,000,000 acre-feet, or even more. The number is consequently of small significance.

TABLE 32.—NUMBER AND CAPACITY OF RESERVOIRS, BY STATES: 1930 AND 1920

STATE	NUMBER		CAPACITY	
	1930	1920	1930	1920
Total (19 States)	5,122	7,538	*Acre-feet* 24,508,590	*Acre-feet* 21,246,436
Arizona	378	340	3,410,975	1,510,856
Arkansas	10	16	7,342	20
California	1,769	3,030	3,225,675	1,091,394
Colorado	765	979	1,924,982	2,406,372
Idaho	155	249	3,645,373	3,493,511
Kansas	19	36	66,293	391
Louisiana	85	74	13,909	7,632
Montana	282	468	857,067	1,571,720
Nebraska	40	59	199,185	197,890
Nevada	209	134	529,369	504,428
New Mexico	240	328	2,945,220	2,960,718
North Dakota	8	9	1,466	1,110
Oklahoma	7	8	293	52
Oregon	120	266	1,698,428	1,905,037
South Dakota	5	119	203,124	212,264
Texas	325	368	935,085	392,999
Utah	413	476	1,093,252	1,600,505
Washington	78	205	699,807	477,789
Wyoming	214	374	3,051,745	2,911,748

Comparison of capacities of reservoirs is affected by the omission from the 1930 figures of a few large reservoirs reported in 1920, which now have their sole usefulness in connection with the development of electric power; by corrections in capacity estimates of others; and by the dropping out of many small reservoirs in both plains and mountain sections, which catch and store storm water. Many of these latter reservoirs originally had the function of storing water for irrigation, but now are used only to water cattle.

Notwithstanding these changes, total storage capacity of irrigation reservoirs increased between 1920 and 1930 by 3,262,154 acre-feet, or more than 15 per cent, the largest increases being shown for California and Arizona.

Table 33 shows capacity and length of main canals and length of lateral canals as reported in 1930 and 1920. Colorado reported both the greatest length and greatest capacity of main canals in 1930 and 1920, but California reported the greatest length of lateral canals in both years.

TABLE 33.—CAPACITY AND LENGTH OF CANALS, BY STATES: 1930 AND 1920

STATE	MAIN CANALS				LATERAL CANALS	
	Capacity		Length		Length	
	1930	1920	1930	1920	1930	1920
Total (19 States)	*Sec.-ft.* 547,314	*Sec.-ft.* 631,079	*Miles* 75,375	*Miles* 103,177	*Miles* 51,427	*Miles* 56,687
Arizona	13,697	11,707	1,732	1,769	2,242	1,599
Arkansas	1,845	1,205	46	68	5	18
California	84,044	115,237	7,588	14,437	11,014	12,947
Colorado	123,052	119,558	15,355	19,022	6,026	8,571
Idaho	76,763	86,273	7,077	11,144	7,267	6,154
Kansas	2,079	1,667	190	271	89	147
Louisiana	11,386	11,889	1,318	1,584	908	1,659
Montana	53,253	94,429	10,577	16,411	5,380	6,085
Nebraska	13,108	11,665	1,432	1,780	2,033	1,545
Nevada	16,986	10,554	3,341	3,123	814	1,245
New Mexico	17,479	23,432	3,405	4,469	1,061	1,463
North Dakota	1,072	836	18	58	69	93
Oklahoma	77	344	23	38	1	19
Oregon	25,906	28,897	5,839	7,115	2,338	1,956
South Dakota	1,995	5,427	354	653	728	605
Texas	21,626	23,261	1,643	1,524	3,236	2,949
Utah	30,648	29,447	5,614	6,343	3,623	5,334
Washington	14,987	16,242	1,774	3,851	1,861	1,764
Wyoming	35,811	39,009	8,043	9,517	2,732	2,534

Comparisons in Table 33 are affected somewhat by an apparent lack of uniformity on the part of enterprises and enumerators in distinguishing between main canals and laterals. As regards the latter, many farm distributaries appear to have been reported as lateral canals in 1920 but omitted, in accordance with instructions, in 1930, while many lateral canals were reported as main canals. The 1930 figures are believed to represent present conditions with approximate correctness.

Table 34 shows length of pipe lines reported in 1930 and 1920, with a distribution of the 1930 lengths according to material. The large increase in total length—approximately 96 per cent—is one of the conspicuous phases of irrigation development in the decade, accompanying, as it did, the very considerable expansion of pumping for irrigation. In both years California accounted for by far the greater part of the mileage, its proportion in 1930 being approximately 84 per cent, and in 1920 approximately 77 per cent. Washington was second in both years, reporting 6.5 per cent and 9 per cent of the total, respectively.

TABLE 34.—LENGTH OF PIPE LINES, 1930 AND 1920, BY MATERIAL, 1930, BY STATES

STATE	TOTAL		MATERIAL, 1930				
	1930	1920	Concrete	Clay	Metal	Wood	Not segregated
Total (19 States)	*Miles* 17,363.1	*Miles* 8,878.3	*Miles* 10,324.5	*Miles* 322.8	*Miles* 4,857.7	*Miles* 1,003.8	*Miles* 854.3
Arizona	189.3	104.5	71.0	0.4	58.1	41.8	18.0
Arkansas	1.0	0.4			1.0		
California	14,683.0	6,885.9	9,585.4	110.7	4,094.2	227.5	665.2
Colorado	131.9	217.3	68.0	10.1	30.3	17.5	
Idaho	263.4	180.6	80.0	11.1	35.1	132.6	4.6
Kansas	16.1	2.8			16.1		
Louisiana	15.1	50.1			14.6	0.5	
Montana	64.9	48.0	12.3	9.2	27.6	15.8	
Nebraska	27.5	3.8	6.6	9.5	3.9	7.5	
Nevada	90.6	33.0	11.6	8.3	58.2	10.7	1.8
New Mexico	15.2	60.8	0.7	1.0	10.0	3.5	
North Dakota	1.2	0.3			1.2		
Oklahoma	0.7	4.3			0.7		
Oregon	226.3	159.6	61.5	0.9	80.7	70.4	11.8
South Dakota	8.9	7.2	1.1	2.4	3.6	1.8	
Texas	319.0	157.1	149.8	1.6	58.6	56.0	53.0
Utah	159.0	154.7	24.0	55.5	49.2	30.3	
Washington	1,136.9	790.0	249.7	99.6	300.6	387.1	99.9
Wyoming	14.1	17.9	2.8	2.5	8.0	0.8	

Concrete pipe is 59.5 per cent of all pipe reported in 1930, as measured by length; metal pipe is 28 per cent; wood, 5.8 per cent; clay, 1.9 per cent; and unsegregated materials, 4.9 per cent. California leads in the mileage of concrete, metal, and clay pipe, having of their total length 92.8 per cent, 84.3 per cent, and 34.3 per cent, respectively. Washington shows the largest proportion of the total length of wood pipe, 38.6 per cent, California being next with 22.7 per cent.

Table 35 shows number and capacity of flowing wells, by States, for 1930 and 1920. The total number for 1930 represents a small increase over the 1920 number, but the total capacity has decreased. Increases in both number and capacity are shown for Colorado, Idaho, Louisiana, South Dakota, and Utah; Nevada shows an increase in number but decrease in capacity; Washington and Wyoming, though reporting fewer wells, report larger capacities.

The State reporting the largest number of flowing wells in 1930 is Utah, displacing California, which led in number in 1920 and was second in capacity. As in 1920, New Mexico led in capacity of wells in 1930.

The large increases shown for Louisiana are attributable to the inclusion in the 1930 irrigation census, of the strawberry sections of Tangipahoa Parish, which were not reported in 1920. Many of these sections are irrigated by flowing wells.

TABLE 35.—NUMBER AND CAPACITY OF FLOWING WELLS, BY STATES: 1930 AND 1920

STATE	FLOWING WELLS			
	Number		Capacity	
	1930	1920	1930	1920
Total (16 States [1])	4,811	4,606	*G. p. m.* 699,367	*G. p. m.* 935,057
Arizona	215	310	13,772	14,547
California	449	1,415	65,768	287,187
Colorado	621	476	30,644	20,139
Idaho	220	142	30,108	15,133
Kansas	1	6	75	500
Louisiana	807	9	31,961	6,255
Montana	40	41	4,106	4,608
Nevada	274	123	19,131	21,942
New Mexico	340	556	223,257	376,222
Oklahoma		1		100
Oregon	59	65	6,535	11,068
South Dakota	13	4	4,825	2,750
Texas	61	135	36,020	62,364
Utah	1,663	1,256	104,670	96,371
Washington	42	60	27,290	14,025
Wyoming	6	7	2,205	46

[1] None reported for Arkansas, Nebraska, and North Dakota.

PUMPING FOR IRRIGATION

Areas in pumping enterprises.—The Summary for the 19 irrigation States and the reports for the separate States contain data on the areas irrigated from sources made available by pumps, on the investment in enterprises which include these areas, and on pumping equipment. This section contains additional information regarding pumping equipment and brings together that found in other sections in order to make a complete presentation of the data relating to pumping for irrigation collected in the Fifteenth Census, with such comparisons with the results of the Fourteenth Census as can be made.

The advance of pumping, whether as a substitute for other methods of making water available or as a supplement to them, was one of the conspicuous phases of irrigation development in the 1919–1929 decade. This is exemplified strikingly by the figures in Table 36, which show the acreages served either wholly or partly by pumping in the two census years, and by the similar figures on investment in enterprises using pumped water. (Table 37.) Thus Table 36 shows that the area served wholly or partly by pumped water in 1929 was almost double that reported in 1919, the increase being 96 per cent. Moreover, the 6,085,501 acres so served in 1929 were 31.1 per cent of the entire area irrigated in 1929 as compared with 16.2 per cent in 1919.

California, which accounted for more than half (54.8 per cent) of the total in 1929, shows also by far the largest acreage increase over 1919 (2,035,375 acres), but the largest proportionate increase is shown for Nebraska (908.8 per cent), with Utah second (448.4 per cent), and Wyoming third (375.8 per cent).

The figures specifying acreages entirely supplied with pumped water provide a more emphatic measure of the increased importance of pumping than those just discussed or those representing areas partly supplied with pumped water, for the reason that the latter include enterprises the pumping operations of which are of relatively small importance, as well as

other enterprises for which pumping provides the greater part of the irrigation supply. The area entirely supplied with pumped water increased more than half (55.2 per cent) during the 1919–1929 decade, and was 20 per cent of the entire area irrigated in 1929 as compared with 13.2 per cent in 1919. In this comparison, as in those made in the preceding paragraph, California leads, accounting for half (50 per cent) of the total in 1929 and 44.6 per cent in 1919. California led also in acreage increase (832,890 acres) during the decade. Higher proportionate increases are shown for Nebraska, Wyoming, Utah, Washington, Montana, Arizona, New Mexico, and Colorado, but in several of those States the areas served are of relative insignificance. Only North Dakota, Oregon, and South Dakota reported smaller acreages entirely supplied by pumps in 1929 than in 1919.

Of the area supplied entirely by pumping, wells irrigated 52.3 per cent in 1929 and 50 per cent in 1919; streams irrigated 43.7 per cent in 1929 and 48.6 per cent in 1919; lakes irrigated 2 per cent in 1929 and 1.4 per cent in 1919; and other sources irrigated 1.9 per cent in 1929, no acreage being reported in 1919.

The total area partly supplied by pumping increased by 1,586,523 acres, or 273.5 per cent, during the decade. As in the case of the area entirely supplied by pumping, California accounted for much (75.8 per cent) of this increase. The combination principally accounting for the increase in the total figures and the portion of it representing California is the "streams, gravity and wells, pumped" combination, which increased 788.5 per cent. This classification does not include the "supplemental from pumped wells" figure, shown for 1929 at the conclusion of the table. This also is comprised mostly of California lands which receive their principal irrigation supply from gravity canals operated by large enterprises. The wells are mostly owned by individual farmers, who operate them in emergencies when the canal supplies are depleted.

Table 36 shows, in addition to the areas irrigated in 1929, the area which enterprises operating pumps were capable of supplying with water in 1930 and the irrigable area in enterprises in 1930.

Investment in pumping enterprises.—Classifications used in Table 36 are repeated in Table 37 to show investment in and cost of maintenance and operation of enterprises using pumped water. The 1930 investment in such enterprises, $553,456,976, is 53.6 per cent of the investment in all enterprises. The corresponding 1920 proportion was 25.6 per cent. The proportionate increase of investment in enterprises using pumped water, during the 1919–1929 decade, was 210 per cent, as compared with the 96 per cent increase in acreage. The highest actual increase is shown by California, the figure being $290,491,194. Arizona shows the next highest actual increase, $31,790,390, and Washington is third, with $12,967,260. Highest proportionate increases are as follows: Nebraska, 717.1 per cent; Utah, 388.6 per cent; California, 340.6 per cent; and Oregon, 231.8 per cent.

As in the case of areas, the investment in enterprises entirely supplied by pumped water constitutes the greater part (69.1 per cent) of the total investment shown in the table. Of the investment in enterprises entirely supplied with pumped water, 70.9 per cent is provided by wells, 26.7 per cent by streams, 0.9 per cent by lakes, and 1.5 per cent by other pumped sources. Between 1920 and 1930 the investment in enterprises dependent upon well water increased by 253.7 per cent, and the average, per acre, from $45.82 to $110.07; the investment in enterprises pumping their entire supply from streams increased 72.1 per cent, and the average, per acre, from $27.97 to $37.67; the investment in enterprises pumping their entire supply from lakes increased 58.8 per cent, but the average per acre decreased from $37.84 to $26.43. For enterprises utilizing "other sources" in 1930, the average investment, per acre, was $52.11.

The investment in enterprises for which a part of the water supply is pumped increased by 324.1 per cent; but the average per acre declined from $60.05 to $59.15. The combination source accounting for the greater part of the investment, 58.6 per cent, is "streams, gravity and wells, pumped;" "streams, gravity and pumped" account for 12.2 per cent; "wells, pumped and flowing," 0.9 per cent; "supplemental from pumped streams," 0.5 per cent; "supplemental from pumped wells," 5.6 per cent; and "other sources," 22.2 per cent.

The classifications representing enterprises wholly dependent upon pumping show for the 19 States a consistently lower cost of maintenance and operation per acre in 1929 than in 1919, notwithstanding the fact brought out in other tables (for instance, Table 38) that pumping lifts increased somewhat in the decade. The lowered cost reflects in part, at least, the reduction in rates charged for electric current and cheaper fuel oil, as well as the fact that most of the newer pumping installations are more efficient than many older plants. This lowered figure is not so consistently shown by the enterprises only partly dependent upon pumping, perhaps because of the greater variety of expenditures entering into their costs.

Pumping equipment.—Table 38 distributes the pumping equipment reported in 1930 and 1920, by kind of power, kind of pump, and by States.

The most conspicuous change shown in the section devoted to kind of power, is the large increase (203.2 per cent) in the capacity of electric motors, the plants reported in 1930 showing 876,166 horsepower as compared with 289,018 horsepower in 1920. The power capacity of internal-combustion engines increased by 2.4 per cent, and that of water-driven plants by 49 per cent, the latter, however, representing a relatively unimportant phase of irrigation pumping. Steam and wind driven plants show much smaller total capacities for 1930 than for 1920. The various combinations of power represent installations for which combined power capacities, but not the power of the separate units, were reported. Of these, only "electricity and internal combustion" and "electricity and steam" reported as much as 1 per cent of the total in 1930, although they, together with the other combinations shown, constituted approximately 10 per cent in 1920. The total capacity of all plants increased by 71.4 per cent, from 748,971 horsepower in 1920 to 1,283,419 horsepower in 1930.

The number of pumps increased by an even larger proportion (81.8 per cent), from 33,804 in 1920 to 61,445 in 1930, while the total capacity of pumps increased 57.8 per cent, from 36,275,005 gallons per minute to 57,244,859 gallons per minute. The increase in the number of pumps operated by electric motors was notably large (246.6 per cent), from 12,743 to 44,165. This increase in number represented an increase in capacity of 180.7 per cent, from 13,311,435 gallons per minute to 37,365,179 gallons per minute.

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Although the power capacity of internal-combustion engines showed an increase of 2.4 per cent, the number of the pumps operated by them was smaller in 1930 than in 1920. Both number and capacity of pumps operated by steam engines decreased. Number and capacity of pumps operated by water and wind driven plants were not large in either year.

The average static lift of all pumps increased by 24.4 per cent from 41 feet in 1920 to 51 feet in 1930.

In 1930, as in 1920, centrifugal pumps were the most numerous of the types used in irrigation, their increase in the decade being 33.8 per cent; increase in their capacity was 66.7 per cent; and increase in the power capacity of their engines or motors was 24.9 per cent. Relatively, however, their importance was not so prominent in 1930 as in 1920, since in 1930 they constituted only 56.6 per cent of all pumps, as compared with 77 per cent in 1920; their capacity in 1930 was 66.7 per cent of the capacity of all pumps as compared with 80.6 per cent in 1920; and the power capacity of their engines or motors was 56.6 per cent as compared with 77.6 per cent in 1920. Turbine pumps, on the other hand, show very large increases, both actually and relatively, while conspicuous increases are shown also by rotary pumps. It is probable, in fact, that the increase in the use of turbine pumps has been even larger than that suggested by this tabulation, for reasons given in the last paragraph on page 2, since many sections, where the lowered water table resulting from the rapid expansion of pumping from wells has necessitated the abandonment of low-lift pumps, have witnessed their replacement by pumps of the turbine type.

As is shown in Table 38 on page 41, California has increased its lead in pumping equipment, its number of pumps constituting 71.4 per cent of the total in 1920 and 78.1 per cent in 1930; their capacity increased from 46.2 per cent of the total in 1920 to 58.1 per cent in 1930; and the power capacity of their engines or motors from 51.6 per cent of the total in 1920 to 63.9 per cent in 1930. Of next importance to California is Texas, with Louisiana third in point of engine or motor and pump capacity, although reporting fewer pumps than Washington.

While relatively few of the figures (Table 38) entering into the totals for plant capacity, pump capacity, and average lift represent accurate measurements (see las paragraph on p. 2), it is worthy of note that plan efficiency as represented by these totals approximates 57 per cent. The corresponding ratio for 1920 was approximately 49 per cent.

Pumped wells.—Continuing the final section of Table 38, Table 39 shows the number and capacity of pumped wells, by States, for 1930 and 1920. Of notable significance in this tabulation is the fact that the increase in capacity of wells has, in general and for most of the States, been substantially higher than the increase in number. In other words, the newer wells are larger, in point of capacity, than the older ones.

As in the case of pumping plants and pumps, between 1920 and 1930, California advanced its leadership in number and capacity of pumped wells, having 82.4 per cent of the total number and 74.7 per cent of the total capacity in 1930, as compared with 79.1 per cent of the total number and 64.7 per cent of the total capacity in 1920. Whereas the number of pumped wells increased 21,336 and their capacity 13,657,691 gallons per minute, in none of the other States was the increase in number as much as 600 or the increase in capacity as much as 800,000 gallons per minute. Next to California, the largest increase in number of wells is that shown for Louisiana, while Arizona shows the next largest increase in capacity.

Character of pumping enterprises.—Table 40 distributes number and capacity of pumping plants and pumps by character of enterprise. It shows the preponderance of plants which in 1930, as in 1920, were owned by individuals and partnerships. While the relative standing of the plants constituting this group (95 per cent of the total in 1930 and 96.2 per cent of the total in 1920) shows little change, the 1930 number represents an increase of 99 per cent over the number reported in 1920. Corresponding percentages for pumps are smaller but not significantly so.

Date of beginning of pumping enterprises.—Table 41 distributes the number and capacity of pumping plants and pumps by the dates of beginning of the enterprises operating them. While this tabulation establishes the general fact that the present importance of pumping represents a development of recent years, its identification with specified periods is not accurate because of the large proportion (38.6 per cent) of the enumerated plants in the "not reported" group. Of the 22,918 plants in this group, 20,088 are in California, and most of them appear to have been installed since 1920.

TABLE 36.—AREA IRRIGATED WITH PUMPED WATER, 1929 AND 1919; AREA ENTERPRISES OPERATING PUMPS WERE CAPABLE OF SUPPLYING WITH WATER AND IRRIGABLE AREA IN ENTERPRISES OPERATING PUMPS, 1930; BY SOURCE OF PUMPED WATER, BY STATES

	ITEM (See definitions in Introduction)			TOTAL	Arizona	Arkansas	California	Colorado	Idaho	Kansas	Louisiana	Montana	Nebraska
1	**Total area entirely and partly supplied with pumped water**	1929	acres	6,085,501	408,589	151,305	3,333,798	56,815	300,579	16,612	449,695	107,243	26,402
2		1919	acres	3,105,331	264,727	141,969	1,208,423	49,505	114,734	16,155	433,316	35,988	2,626
3	Increase, 1919–1929		per cent	96.0	54.3	6.6	156.8	14.8	162.0	2.8	3.8	198.6	908.8
	ENTIRE SUPPLY PUMPED												
4	Area irrigated	1929	acres	3,918,985	112,761	149,555	1,959,577	42,421	120,921	15,157	448,339	44,419	26,272
5		1919	acres	2,525,398	46,370	141,719	1,126,087	23,732	112,507	13,905	409,576	15,961	1,661
6	Increase,[1] 1919–1929		per cent	55.2	143.2	5.5	73.9	78.8	7.5	8.5	9.5	178.3	-------
7	Area enterprises were capable of supplying with water	1930	acres	5,420,619	161,384	206,766	2,507,713	66,642	173,403	22,372	792,008	61,699	37,236
8	Irrigable area in enterprises	1930	acres	6,372,291	329,768	222,816	2,782,430	83,410	174,020	23,974	845,851	66,035	40,341
	PUMPED FROM—												
	Streams:												
9	Area irrigated	1929	acres	1,713,380	8,123	1,502	469,944	27,705	103,362	3,216	257,390	38,620	2,458
10		1919	acres	1,226,510	6,671	6,009	205,073	12,747	107,181	730	248,306	15,743	1,115
11	Increase,[1] 1919–1929		per cent	39.7	21.8	−75.0	58.9	117.8	−3.6	340.5	3.7	145.3	120.4
12	Proportion of total	1929	per cent	100.0	0.5	0.1	27.4	1.6	6.0	0.2	15.0	2.3	0.1
13		1919	per cent	100.0	0.5	0.5	24.1	1.6	8.7	0.1	20.2	1.3	0.1
14	Area enterprises were capable of supplying with water	1930	acres	2,708,769	12,380	1,717	818,004	48,331	114,487	4,010	518,225	51,004	5,485
15	Irrigable area in enterprises	1930	acres	3,383,188	146,070	2,422	933,878	60,801	115,764	4,777	543,322	55,355	6,340
	Wells:												
16	Area irrigated	1929	acres	2,051,735	104,637	142,078	1,453,272	12,143	3,546	11,048	172,095	243	23,452
17		1919	acres	1,263,998	39,694	135,260	826,846	10,114	414	13,235	154,304	139	546
18	Increase,[1] 1919–1929		per cent	62.4	163.6	5.7	75.8	20.1	756.5	−12.0	11.9	74.8	-------
19	Proportion of total	1929	per cent	100.0	5.1	7.0	70.8	0.6	0.2	0.5	8.4	(2)	1.1
20		1919	per cent	100.0	3.1	10.7	65.5	0.8	(2)	1.0	12.2	(2)	(2)
21	Area enterprises were capable of supplying with water	1930	acres	2,465,888	149,003	199,849	1,648,280	15,463	4,443	18,069	240,005	280	30,922
22	Irrigable area in enterprises	1930	acres	2,725,036	183,097	215,144	1,800,944	18,021	4,675	18,852	266,291	364	33,172
	Lakes:												
23	Area irrigated	1929	acres	77,818	-------	75	4,097	405	5,144	-------	1,439	5,528	255
24		1919	acres	35,730	5	450	4,168	871	4,912	-------	6,966	79	-------
25	Increase,[1] 1919–1929		per cent	117.8	−100.0	−83.3	−1.7	−53.5	4.7	-------	−79.1	-------	-------
26	Proportion of total	1929	per cent	100.0	-------	0.1	5.3	0.5	6.6	-------	1.9	7.1	0.3
27		1919	per cent	100.0	(2)	1.3	11.7	2.4	13.7	-------	19.5	0.2	-------
28	Area enterprises were capable of supplying with water	1930	acres	135,880	-------	200	4,524	410	38,645	-------	1,859	10,288	540
29	Irrigable area in enterprises	1930	acres	138,504	-------	250	4,884	410	38,672	-------	1,859	10,288	540
	Other sources:												
30	Area irrigated	1929	acres	76,052	1	5,000	32,204	2,108	8,869	293	16,795	28	107
31	Proportion of total	1929	per cent	100.0	(2)	6.6	42.4	2.8	11.7	0.4	22.1	(2)	0.1
32	Area enterprises were capable of supplying with water	1930	acres	110,082	1	5,000	38,905	2,438	15,828	293	31,919	28	289
33	Irrigable area in enterprises	1930	acres	124,963	1	5,000	42,724	3,578	15,828	345	34,379	28	289
	PART SUPPLY PUMPED												
34	Area irrigated	1929	acres	2,166,516	295,828	1,750	1,374,221	14,394	179,658	1,455	1,356	62,824	220
35		1919	acres	579,993	218,357	250	171,736	25,773	2,227	2,190	23,740	20,027	905
36	Increase,[1] 1919–1929		per cent	273.5	35.5	600.0	700.2	−44.2	-------	−33.6	−94.3	213.7	−77.2
37	Area enterprises were capable of supplying with water	1930	acres	2,885,438	391,801	2,694	1,821,902	16,055	215,824	1,962	2,845	114,194	315
38	Irrigable area in enterprises	1930	acres	3,078,871	432,793	2,694	1,922,403	16,690	218,507	2,022	2,905	127,541	405
	SUPPLIED FROM—												
	Streams, gravity and pumped:												
39	Area irrigated	1929	acres	258,094	53	-------	85,169	2,828	76,894	-------	-------	50,970	-------
40		1919	acres	199,595	-------	-------	60,278	9,430	1,870	600	12,020	19,872	850
41	Increase,[1] 1919–1929		per cent	29.3	-------	-------	41.3	−70.0	-------	−100.0	−100.0	156.7	−100.0
42	Proportion of total	1929	per cent	100.0	(2)	-------	33.0	1.1	29.8	-------	-------	19.7	-------
43		1919	per cent	100.0	-------	-------	30.2	4.7	0.9	0.3	6.3	10.0	0.4
44	Area enterprises were capable of supplying with water	1930	acres	437,233	70	-------	200,955	3,032	90,212	-------	-------	104,449	-------
45	Irrigable area in enterprises	1930	acres	502,675	105	-------	248,015	3,052	90,212	-------	-------	117,276	-------
	Wells, pumped and flowing:												
46	Area irrigated	1929	acres	16,798	258	-------	9,761	-------	50	-------	190	-------	-------
47		1919	acres	35,685	558	-------	23,561	85	-------	50	1,075	-------	-------
48	Increase,[1] 1919–1929		per cent	−52.9	−53.8	-------	−58.6	−100.0	-------	−100.0	−81.8	-------	-------
49	Proportion of total	1929	per cent	100.0	1.5	-------	58.1	-------	0.3	-------	1.2	-------	-------
50		1919	per cent	100.0	1.6	-------	66.0	0.2	-------	0.1	3.0	-------	-------
51	Area enterprises were capable of supplying with water	1930	acres	20,767	438	-------	11,442	-------	64	-------	220	-------	-------
52	Irrigable area in enterprises	1930	acres	22,087	440	-------	12,528	-------	64	-------	280	-------	-------
	Streams, gravity and wells, pumped:												
53	Area irrigated	1929	acres	1,164,349	292,681	-------	780,960	8,956	72,950	405	-------	2,694	70
54		1919	acres	344,713	217,799	250	87,897	10,258	357	1,540	10,045	155	115
55	Increase,[1] 1919–1929		per cent	237.8	34.4	−100.0	788.5	−44.9	-------	−73.7	−100.0	-------	−39.1
56	Proportion of total	1929	per cent	100.0	25.1	-------	67.1	0.8	6.3	(2)	-------	0.2	(2)
57		1919	per cent	100.0	63.2	0.1	25.5	4.7	0.1	0.4	2.9	(2)	(2)
58	Area enterprises were capable of supplying with water	1930	acres	1,507,586	358,891	-------	1,022,726	9,412	90,044	800	-------	4,520	70
59	Irrigable area in enterprises	1930	acres	1,559,322	390,424	-------	1,039,420	9,680	92,583	800	-------	4,820	220
	Other combinations:												
60	Area irrigated	1929	acres	409,378	1,164	1,750	208,742	740	20,720	-------	960	3,160	150
61	Proportion of total	1929	per cent	100.0	0.3	0.4	51.0	0.2	5.1	-------	0.2	0.8	(2)
62	Area enterprises were capable of supplying with water	1930	acres	565,317	30,709	2,694	268,394	840	26,120	-------	975	5,225	245
63	Irrigable area in enterprises	1930	acres	610,124	40,073	2,694	275,466	950	26,150	-------	975	5,445	245
	Supplemental from pumped streams:												
64	Area irrigated	1929	acres	24,871	80	-------	2,453	527	8,915	-------	60	-------	-------
65	Proportion of total	1929	per cent	100.0	0.3	-------	9.9	2.1	35.9	-------	0.2	-------	-------
66	Area enterprises were capable of supplying with water	1930	acres	32,787	98	-------	4,046	542	9,250	-------	1,000	-------	-------
67	Irrigable area in enterprises	1930	acres	34,208	156	-------	4,160	592	9,425	-------	1,000	-------	-------
	Supplemental from pumped wells:												
68	Area irrigated	1929	acres	293,026	1,592	-------	287,130	1,343	120	1,050	200	-------	-------
69	Proportion of total	1929	per cent	100.0	0.5	-------	98.0	0.5	(2)	0.3	0.1	-------	-------
70	Area enterprises were capable of supplying with water	1930	acres	321,748	1,595	-------	314,399	2,229	128	1,162	650	-------	-------
71	Irrigable area in enterprises	1930	acres	350,455	1,595	-------	342,814	2,416	133	1,222	650	-------	-------

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

[2] Less than one-tenth of 1 per cent.

TABLE 36.—AREA IRRIGATED WITH PUMPED WATER, 1929 AND 1919; AREA ENTERPRISES OPERATING PUMPS WERE CAPABLE OF SUPPLYING WITH WATER AND IRRIGABLE AREA IN ENTERPRISES OPERATING PUMPS, 1930; BY SOURCE OF PUMPED WATER, BY STATES—Continued

	ITEM (See definitions in Introduction)	Nevada	New Mexico	North Dakota	Oklahoma	Oregon	South Dakota	Texas	Utah	Washington	Wyoming
1	**Total area entirely and partly supplied with pumped water**—1929—acres	7,876	44,453	1,669	458	146,050	61	600,833	161,503	261,611	9,859
2	1919—acres	8,684	25,496	2,469	295	68,887	1,369	464,149	29,450	145,017	2,072
3	Increase,[1] 1919–1929—per cent	−9.3	74.4	−32.4	55.3	112.0	−95.5	29.4	448.4	80.4	375.8
	ENTIRE SUPPLY PUMPED										
4	Area irrigated—1929—acres	3,136	37,541	1,669	458	62,024	61	593,248	123,948	167,803	9,675
5	1919—acres	2,942	17,599	2,469	295	68,189	869	461,618	29,097	48,410	1,672
6	Increase,[1] 1919–1929—per cent	6.6	113.3	−32.4	55.3	−9.0	−93.0	28.5	326.0	246.6	478.6
7	Area enterprises were capable of supplying with water—1930—acres	8,295	44,332	1,824	931	100,136	246	893,185	140,540	186,689	15,218
8	Irrigable area in enterprises—1930—acres	10,078	46,517	1,894	944	109,006	251	1,126,060	169,543	322,284	17,100
	PUMPED FROM—										
	Streams:										
9	Area irrigated—1929—acres	821	6,856	1,669	320	50,537	61	527,700	63,809	139,738	9,489
10	1919—acres	2,647	1,890	2,469	188	64,576	869	421,538	10,389	26,244	1,525
11	Increase,[1] 1919–1929—per cent	−69.0	262.8	−32.4	70.2	−21.7	−93.0	25.2	514.2	432.5	522.2
12	Proportion of total—1929—per cent	(2)	0.4	0.1	(2)	2.9	(2)	30.8	3.7	8.2	0.6
13	1919—per cent	0.2	0.2	0.2	(2)	5.3	0.1	34.4	0.8	2.1	0.1
14	Area enterprises were capable of supplying with water—1930—acres	1,026	10,071	1,824	630	83,624	246	801,502	65,303	155,943	14,867
15	Irrigable area in enterprises—1930—acres	1,486	11,094	1,894	630	91,415	251	1,011,091	90,584	288,026	16,798
	Wells:										
16	Area irrigated—1929—acres	2,117	30,425	-------	63	3,804	-------	60,793	10,283	19,456	180
17	1919—acres	295	15,709	-------	107	1,993	-------	39,483	7,308	17,504	147
18	Increase,[1] 1919–1929—per cent	617.6	93.7	-------	−41.1	90.9	-------	54.0	40.7	11.2	22.4
19	Proportion of total—1929—per cent	0.1	1.5	-------	(2)	0.2	-------	3.0	0.5	0.9	(2)
20	1919—per cent	(2)	1.2	-------	(2)	0.2	-------	3.1	0.6	1.4	(2)
21	Area enterprises were capable of supplying with water—1930—acres	7,071	33,864	-------	66	4,179	-------	82,296	12,092	21,712	285
22	Irrigable area in enterprises—1930—acres	7,734	35,026	-------	79	4,071	-------	97,800	14,814	23,006	296
	Lakes:										
23	Area irrigated—1929—acres	-------	15	-------	35	6,092	-------	1,861	49,451	3,395	6
24	1919—acres	-------	-------	-------	-------	1,620	-------	597	11,400	4,662	-------
25	Increase,[1] 1919–1929—per cent	-------	-------	-------	-------	276.0	-------	211.7	333.8	−27.2	-------
26	Proportion of total—1929—per cent	-------	(2)	-------	(2)	7.8	-------	2.4	63.5	4.4	(2)
27	1919—per cent	-------	-------	-------	-------	4.5	-------	1.7	31.9	13.0	-------
28	Area enterprises were capable of supplying with water—1930—acres	-------	65	-------	35	10,354	-------	2,592	62,615	3,717	66
29	Irrigable area in enterprises—1930—acres	-------	65	-------	35	10,698	-------	3,013	63,615	4,109	66
	Other sources:										
30	Area irrigated—1929—acres	198	245	-------	40	1,591	-------	2,894	405	5,214	-------
31	Proportion of total—1929—per cent	0.3	0.3	-------	(2)	2.1	-------	3.8	0.5	6.8	-------
32	Area enterprises were capable of supplying with water—1930—acres	198	332	-------	200	1,979	-------	6,825	530	5,317	-------
33	Irrigable area in enterprises—1930—acres	858	332	-------	200	2,222	-------	13,096	530	5,553	-------
	PART SUPPLY PUMPED										
34	Area irrigated—1929—acres	4,740	6,912	-------	-------	84,026	-------	7,585	37,555	93,808	184
35	1919—acres	5,742	7,897	-------	-------	698	500	2,531	353	90,607	400
36	Increase,[1] 1919–1929—per cent	−17.5	−12.5	-------	-------	-------	−100.0	199.7	-------	−2.9	−54.0
37	Area enterprises were capable of supplying with water—1930—acres	22,884	8,232	-------	-------	102,803	-------	10,741	44,856	128,083	187
38	Irrigable area in enterprises—1930—acres	35,258	8,234	-------	-------	106,862	-------	14,360	46,743	141,087	247
	SUPPLIED FROM—										
	Streams, gravity and pumped:										
39	Area irrigated—1929—acres	-------	-------	-------	-------	14,636	-------	3,200	14,200	4,144	-------
40	1919—acres	720	-------	-------	-------	253	-------	350	50	92,702	-------
41	Increase,[1] 1919–1929—per cent	−100.0	-------	-------	-------	-------	-------	814.3	-------	−95.5	-------
42	Proportion of total—1929—per cent	-------	-------	-------	-------	5.6	-------	1.2	5.5	1.6	-------
43	1919—per cent	0.4	-------	-------	-------	0.1	-------	0.2	(2)	46.4	-------
44	Area enterprises were capable of supplying with water—1930—acres	-------	-------	-------	-------	14,636	-------	4,700	14,200	4,979	-------
45	Irrigable area in enterprises—1930—acres	-------	-------	-------	-------	17,636	-------	7,200	14,200	4,979	-------
	Wells, pumped and flowing:										
46	Area irrigated—1929—acres	177	5,855	-------	-------	-------	-------	-------	-------	-------	-------
47	1919—acres	65	6,556	-------	-------	340	-------	1,727	398	103	-------
48	Increase,[1] 1919–1929—per cent	172.3	−10.7	-------	-------	−100.0	-------	−100.0	178	1,490	-------
49	Proportion of total—1929—per cent	1.1	34.8	-------	-------	-------	-------	-------	123.6	−93.1	-------
50	1919—per cent	0.2	18.4	-------	-------	1.0	-------	4.8	2.4	0.6	-------
51	Area enterprises were capable of supplying with water—1930—acres	189	6,879	-------	-------	-------	-------	-------	0.5	4.2	-------
52	Irrigable area in enterprises—1930—acres	256	6,879	-------	-------	-------	-------	-------	518	1,017	-------
	Streams, gravity and wells, pumped:								623	1,017	-------
53	Area irrigated—1929—acres	2,260	655	-------	-------	994	-------	850	20	708	137
54	1919—acres	4,957	1,341	-------	-------	105	500	454	125	2,415	400
55	Increase,[1] 1919–1929—per cent	−54.4	−51.2	-------	-------	846.7	−100.0	87.2	−84.0	−70.7	−65.8
56	Proportion of total—1929—per cent	0.2	(2)	-------	-------	(2)	-------	(2)	(2)	(2)	(2)
57	1919—per cent	1.4	0.4	-------	-------	(2)	0.1	0.1	(2)	0.7	0.1
58	Area enterprises were capable of supplying with water—1930—acres	17,045	935	-------	-------	1,158	-------	860	20	965	140
59	Irrigable area in enterprises—1930—acres	17,045	935	-------	-------	1,174	-------	929	20	1,072	200
	Other combinations:										
60	Area irrigated—1929—acres	2,303	382	-------	-------	59,897	-------	3,281	22,046	84,096	47
61	Proportion of total—1929—per cent	0.5	0.1	-------	-------	14.6	-------	0.8	5.4	20.5	(2)
62	Area enterprises were capable of supplying with water—1930—acres	5,650	398	-------	-------	75,323	-------	3,481	29,184	116,032	47
63	Irrigable area in enterprises—1930—acres	17,957	400	-------	-------	75,390	-------	4,531	30,966	128,835	47
	Supplemental from pumped streams:										
64	Area irrigated—1929—acres	-------	20	-------	-------	7,887	-------	254	75	4,600	-------
65	Proportion of total—1929—per cent	-------	0.1	-------	-------	31.7	-------	1.0	0.3	18.5	-------
66	Area enterprises were capable of supplying with water—1930—acres	-------	20	-------	-------	11,074	-------	1,700	118	4,933	-------
67	Irrigable area in enterprises—1930—acres	-------	20	-------	-------	12,050	-------	1,700	118	4,987	-------
	Supplemental from pumped wells:										
68	Area irrigated—1929—acres	-------	-------	-------	-------	612	-------	-------	816	157	-------
69	Proportion of total—1929—per cent	-------	-------	-------	-------	0.2	-------	-------	0.3	(2)	-------
70	Area enterprises were capable of supplying with water—1930—acres	-------	-------	-------	-------	612	-------	-------	816	157	-------
71	Irrigable area in enterprises—1930—acres	-------	-------	-------	-------	612	-------	-------	816	197	-------

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

[2] Less than one-tenth of 1 per cent.

TABLE 37.—INVESTMENT, 1930 AND 1920, AND COST OF MAINTENANCE AND OPERATION, 1929 AND 1919, OF ENTERPRISES USING PUMPED WATER, BY SOURCE OF SUPPLY, BY STATES

[Statistics for investment, 1920 in "Total" column revised]

	ITEM (See definitions in Introduction)	TOTAL	Arizona	Arkansas	California	Colorado	Idaho	Kansas	Louisiana	Montana	Nebraska
1	**Total investment, entire supply pumped and part supply pumped**—1930—dollars	553,456,978	52,877,571	6,824,598	375,767,865	6,452,510	14,516,484	856,726	15,505,090	6,860,390	707,372
2	1920—dollars	178,519,476	21,087,181	7,143,223	85,276,671	3,486,853	5,906,728	868,257	13,504,057	2,540,067	86,566
3	Increase,[1] 1920–1930—per cent	210.0	150.8	−4.5	340.6	85.1	145.8	−1.3	14.8	170.1	717.1
	ENTIRE SUPPLY PUMPED										
4	Investment, total—1930—dollars	382,782,577	10,206,959	6,773,348	275,252,088	6,001,642	6,233,156	783,606	15,446,414	2,419,277	699,042
5	1920—dollars	138,274,490	3,939,591	7,134,723	70,414,827	2,893,707	5,678,828	763,725	13,062,862	924,751	62,831
6	Increase,[1] 1920–1930—per cent	176.8	159.1	−5.1	290.9	107.4	9.8	2.6	18.2	161.6	
7	Average, per acre—1930—dollars	70.62	63.25	32.76	109.76	90.06	35.95	35.03	19.50	39.21	18.77
8	1920—dollars	35.88	56.94	40.52	45.32	77.19	40.20	34.46	19.87	24.92	17.88
	SUPPLIED FROM—										
	Streams:										
9	Investment—1930—dollars	102,027,681	1,459,527	30,675	31,603,584	5,451,389	5,218,180	176,378	8,831,806	2,208,928	71,933
10	1920—dollars	59,271,070	521,852	96,450	16,267,561	2,490,000	5,108,912	22,142	7,338,954	900,216	39,581
11	Increase,[1] 1920–1930—per cent	72.1	179.7	−68.2	94.3	118.9	2.1	696.6	20.3	145.4	81.7
12	Average, per acre—1930—dollars	37.67	117.39	17.86	38.63	112.79	45.58	43.98	17.04	43.23	13.11
13	1920—dollars	27.97	55.53	14.65	33.83	122.97	38.83	14.37	16.78	24.49	16.04
14	Maintenance and operation cost per acre—1929—dollars	4.30	9.83	6.27	4.47	3.89	4.32	3.43	3.66	2.36	3.85
15	1919—dollars	6.50	8.12	7.06	5.10	9.49	3.43	7.57	7.76	5.63	2.86
	Wells:										
16	Investment—1930—dollars	271,426,464	8,747,182	6,640,773	240,421,609	474,053	87,248	604,328	6,013,183	14,259	616,939
17	1920—dollars	76,741,804	3,417,339	7,028,773	54,057,185	375,277	24,935	741,583	5,366,948	16,285	23,250
18	Increase,[1] 1920–1930—per cent	253.7	156.0	−5.5	344.8	26.3	249.9	−18.5	12.0	−12.4	
19	Average, per acre—1930—dollars	110.07	58.70	33.23	146.04	30.66	19.64	33.44	25.05	49.34	19.95
20	1920—dollars	45.82	57.16	41.70	50.60	23.37	48.61	36.14	25.50	105.44	20.25
21	Maintenance and operation cost per acre—1929—dollars	9.17	10.76	7.04	10.05	5.36	2.30	3.69	4.45	9.38	4.03
22	1919—dollars	10.07	13.15	14.06	10.40	4.54	5.35	6.96	5.95	5.41	5.16
	Lakes:										
23	Investment—1930—dollars	3,591,977		1,900	494,070	13,100	720,528		46,750	194,880	5,000
24	1920—dollars	2,261,616	400	9,500	90,081	27,530	544,981		356,960	8,250	
25	Increase,[1] 1920–1930—per cent	58.8	−100.0	−80.0	448.5	−52.4	32.2		−86.9		
26	Average, per acre—1930—dollars	26.43		9.50	109.21	31.95	18.64		25.15	18.94	9.26
27	1920—dollars	37.84	80.00	10.00	20.34	23.51	59.20		35.20	43.65	
28	Maintenance and operation cost per acre—1929—dollars	3.93		3.49	3.97	3.21	8.51		2.97	4.52	5.88
29	1919—dollars	5.20	10.00	11.78	1.66	3.21	6.72		9.17	11.07	
	Other sources:										
30	Investment—1930—dollars	5,736,455	250	100,000	2,732,825	63,100	207,200	2,900	554,675	1,210	5,170
31	Average, per acre—1930—dollars	52.11	250.00	20.00	70.24	25.88	13.09	9.90	17.38	43.21	17.89
32	Maintenance and operation cost per acre—1929—dollars	7.22	100.00	8.00	7.09	1.28	2.67	0.85	8.20	6.96	6.74
	PART SUPPLY PUMPED										
33	Investment, total—1930—dollars	170,674,399	42,670,612	51,250	100,515,777	450,868	8,283,328	73,120	58,676	4,441,113	8,330
34	1920—dollars	40,244,980	17,147,590	8,500	14,861,844	593,146	227,900	104,532	442,095	1,615,316	23,735
35	Increase,[1] 1920–1930—per cent	324.1	148.8	502.9	576.3	−24.0		−30.1	−86.7	174.9	−64.9
36	Average, per acre—1930—dollars	59.15	108.91	19.02	55.17	28.08	38.88	37.27	20.62	38.89	26.44
37	1920—dollars	60.05	71.02	28.33	78.42	22.60	47.20	27.95	10.53	47.83	17.32
	SUPPLIED FROM—										
	Streams, gravity and pumped:										
38	Investment—1930—dollars	20,823,588	2,550		9,730,362	90,360	5,663,215			4,374,090	
39	1920—dollars	9,406,594			3,084,038	397,392	168,200	50,000	172,000	1,612,316	18,700
40	Increase,[1] 1920–1930—per cent	121.4			215.5	−77.3		−100.0	−100.0	171.3	−100.0
41	Average, per acre—1930—dollars	47.63	36.43		48.42	29.80	62.78			41.88	
42	1920—dollars	39.57			49.02	41.72	37.63	58.82	8.21	47.99	16.40
43	Maintenance and operation cost per acre—1929—dollars	4.41	3.49		8.25	2.72	2.80			1.91	
44	1919—dollars	2.33			1.93	2.34	8.30	20.00	6.06	1.77	1.04
	Wells, pumped and flowing:										
45	Investment—1930—dollars	1,548,810	28,750		1,153,841		28,500		17,326		
46	1920—dollars	2,497,049	54,700		1,776,156	5,300		4,000	22,500		
47	Increase,[1] 1920–1930—per cent	−38.0	−47.4		−35.0	−100.0		−100.0	−23.0		
48	Average, per acre—1930—dollars	74.58	65.64		100.84		445.31		78.75		
49	1920—dollars	58.47	68.46		65.02	33.12		66.67	16.98		
50	Maintenance and operation cost per acre—1929—dollars	9.27	10.64		13.47		16.80		3.90		
51	1919—dollars	8.04	13.64		7.63	4.78			4.19		
	Streams, gravity and wells, pumped:										
52	Investment—1930—dollars	99,936,110	37,553,267		60,683,254	212,058	1,098,605	30,010		25,267	2,330
53	1920—dollars	28,341,343	17,092,890	8,500	10,001,650	190,454	59,700	50,532	247,595	3,000	5,035
54	Increase,[1] 1920–1930—per cent	252.6	119.7	−100.0	506.7	11.3		−40.6	−100.0	742.2	−53.7
55	Average, per acre—1930—dollars	66.29	104.64		59.33	22.53	12.20	37.51		5.59	33.28
56	1920—dollars	72.71	71.03	28.33	100.74	11.50	166.76	17.86	19.05	17.65	21.89
57	Maintenance and operation cost per acre—1929—dollars	4.46	3.06		5.29	1.74	1.55	10.12		1.11	2.86
58	1919—dollars	5.97	2.70	30.15	15.62	0.75	1.00	1.55	10.69	6.67	3.00
	Other combinations:										
59	Investment—1930—dollars	37,811,165	5,027,245	51,250	19,437,761	26,100	1,277,300		28,550	41,750	6,000
60	Average, per acre—1930—dollars	66.89	163.71	19.02	72.42	31.07	48.90		29.28	7.99	24.49
61	Maintenance and operation cost per acre—1929—dollars	4.33	7.73	4.09	6.05	2.38	2.22		3.89	0.72	1.67
	Supplemental from—										
	Pumped streams—										
62	Investment—1930—dollars	927,158	10,200		70,681	67,000	210,208		10,000		
63	Average, per acre—1930—dollars	28.28	104.08		17.47	123.62	22.71		10.00		
64	Maintenance and operation cost per acre—1929—dollars	6.27	14.62		5.39	6.15	6.11				
	Pumped wells—										
65	Investment—1930—dollars	9,627,568	48,600		9,439,878	55,350	5,500	43,110	2,800		
66	Average, per acre—1930—dollars	29.92	30.47		30.03	24.83	42.97	37.10	4.31		
67	Maintenance and operation cost per acre—1929—dollars	5.91	2.44		5.97	5.17	8.62	2.40	3.50		

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

TABLE 37.—INVESTMENT, 1930 AND 1920, AND COST OF MAINTENANCE AND OPERATION, 1929 AND 1919, OF ENTERPRISES USING PUMPED WATER, BY SOURCE OF SUPPLY, BY STATES—Continued

	ITEM (See definitions in Introduction)	Nevada	New Mexico	North Dakota	Oklahoma	Oregon	South Dakota	Texas	Utah	Washington	Wyoming
1	Total investment, entire supply pumped and part supply pumped—1930—dollars	650,144	2,009,411	10,340	25,395	9,857,113	11,423	31,133,165	7,313,634	21,782,541	295,204
2	1920—dollars	335,187	1,524,688	552,007	51,285	2,970,495	96,340	22,649,707	1,496,839	8,815,281	127,144
3	Increase,[1] 1920–1930—per cent	94.0	31.8	−98.1	−50.5	231.8	−88.1	37.5	388.6	147.1	132.2
	ENTIRE SUPPLY PUMPED										
4	Investment, total—1930—dollars	200,831	1,652,607	10,340	25,395	4,967,426	11,423	30,644,803	6,112,809	15,048,157	293,254
5	1920—dollars	139,800	961,523	552,007	51,285	2,952,695	93,340	22,391,970	1,451,168	4,694,483	110,374
6	Increase,[1] 1920–1930—per cent	43.7	71.8	−98.1	−50.5	68.2	−87.8	36.9	321.2	220.5	165.7
7	Average, per acre—1930—dollars	24.21	37.28	5.67	27.28	49.61	46.43	34.31	43.50	80.61	19.27
8	1920—dollars	43.70	36.88	44.89	108.42	34.60	29.07	24.92	29.91	63.12	30.69
	SUPPLIED FROM—										
	Streams:										
9	Investment—1930—dollars	45,000	334,111	10,340	9,670	4,468,284	11,423	26,286,985	4,355,987	11,170,037	283,444
10	1920—dollars	119,900	36,520	552,007	4,210	2,807,806	93,340	19,432,010	733,077	2,605,718	99,914
11	Increase,[1] 1920–1930—per cent	−62.5	814.9	−98.1	129.7	59.1	−87.8	35.3	494.2	328.7	183.7
12	Average, per acre—1930—dollars	43.86	33.18	5.67	15.35	53.43	46.43	32.80	66.70	71.63	19.06
13	1920—dollars	44.82	12.46	44.89	11.86	34.61	29.07	23.70	44.23	52.59	28.98
14	Maintenance and operation cost per acre—1929—dollars	7.01	2.01	1.59	3.00	5.72	8.17	4.96	1.29	3.84	1.58
15	1919—dollars	1.76	1.30	12.21	3.74	3.09	4.03	7.55	5.16	11.16	9.91
	Wells:										
16	Investment—1930—dollars	142,761	1,312,396		12,225	246,833		3,879,881	418,916	1,785,628	8,250
17	1920—dollars	19,900	925,003		47,075	118,306		2,783,260	153,001	1,633,134	10,460
18	Increase,[1] 1920–1930—per cent	617.4	41.9		−74.0	108.6		39.4	173.6	9.3	−21.1
19	Average, per acre—1930—dollars	20.19	38.75		185.23	59.07		47.15	34.64	82.24	28.95
20	1920—dollars	37.98	39.97		398.94	48.93		39.24	11.83	81.91	70.68
21	Maintenance and operation cost per acre—1929—dollars	4.82	6.44		14.30	10.72		8.50	3.58	15.43	34.76
22	1919—dollars	12.10	7.51		40.78	8.04		11.07	2.08	12.71	7.79
	Lakes:										
23	Investment—1930—dollars		500		1,000	185,600		51,737	1,317,256	558,096	1,560
24	1920—dollars					26,583		176,700	565,000	455,631	
25	Increase,[1] 1920–1930—per cent					598.2		−70.7	133.1	22.5	
26	Average, per acre—1930—dollars		7.69		28.57	17.92		20.19	21.04	150.15	23.04
27	1920—dollars					14.88		22.38	29.74	114.51	
28	Maintenance and operation cost per acre—1929—dollars		5.00			2.16		3.69	2.60	19.73	4.17
29	1919—dollars					2.52		6.32	3.58	13.05	
	Other sources:										
30	Investment—1930—dollars	13,070	5,600		2,500	66,709		426,200	20,650	1,534,396	
31	Average, per acre—1930—dollars	66.01	16.87		12.50	33.70		62.45	38.96	288.58	
32	Maintenance and operation cost per acre—1929—dollars	3.21	7.52		5.00	3.07		10.57	5.69	14.20	
	PART SUPPLY PUMPED										
33	Investment, total—1930—dollars	449,313	356,804			4,889,687		488,362	1,200,825	6,734,384	1,050
34	1920—dollars	195,387	563,165			17,800	3,000	257,737	45,071	4,120,798	16,770
35	Increase,[1] 1920–1930—per cent	130.0	−36.6				−100.0	89.5		63.4	−88.4
36	Average, per acre—1930—dollars	19.63	43.34			47.56		45.47	26.77	52.58	10.43
37	1920—dollars	22.17	62.32			25.14	3.00	53.63	65.81	40.68	26.45
	SUPPLIED FROM—										
	Streams, gravity and pumped:										
38	Investment—1930—dollars					347,967		229,067	105,650	280,321	
39	1920—dollars	8,000				3,700		60,000	5,100	3,827,148	
40	Increase,[1] 1920–1930—per cent	−100.0						281.8		−92.7	
41	Average, per acre—1930—dollars					23.77		48.74	7.44	56.30	
42	1920—dollars	11.11				14.07		100.00	25.50	39.97	
43	Maintenance and operation cost per acre—1929—dollars					1.54		8.00	1.73	8.24	
44	1919—dollars	0.76				2.55		8.57		1.99	
	Wells, pumped and flowing:										
45	Investment—1930—dollars	10,760	251,863						20,870	36,900	
46	1920—dollars	5,500	388,165			2,600		163,057	18,571	56,500	
47	Increase,[1] 1920–1930—per cent	95.6	−35.1			−100.0		−100.0	12.4	−34.7	
48	Average, per acre—1930—dollars	56.93	36.61						40.20	36.28	
49	1920—dollars	78.57	52.09			7.65		47.57	71.15	37.92	
50	Maintenance and operation cost per acre—1929—dollars	5.26	3.00						3.49	2.91	
51	1919—dollars	61.77	8.99			18.00		16.69	9.48	1.86	
	Streams, gravity and wells, pumped:										
52	Investment—1930—dollars	119,903	86,301			32,292		43,887	3,500	43,836	1,000
53	1920—dollars	181,887	175,000			11,500	3,000	34,680	22,000	237,150	16,770
54	Increase,[1] 1920–1930—per cent	−34.1	−50.7			180.8	−100.0	26.5	−84.1	−81.5	−90.5
55	Average, per acre—1930—dollars	7.03	92.30			27.89		51.03	175.00	45.42	11.43
56	1920—dollars	22.67	110.48			109.52	3.00	44.58	94.42	58.28	26.45
57	Maintenance and operation cost per acre—1929—dollars	2.29	1.13			5.58		8.84	19.00	8.86	0.52
58	1919—dollars	1.57	39.77			17.89		16.83	2.94	20.70	1.20
	Other combinations:										
59	Investment—1930—dollars	318,650	13,640			4,278,278		213,400	1,047,800	6,043,091	350
60	Average, per acre—1930—dollars	56.40	34.27			56.80		61.30	35.90	52.08	7.45
61	Maintenance and operation cost per acre—1929—dollars	4.22	4.19			1.45		5.66	2.99	3.09	0.85
	Supplemental from—										
	Pumped streams—										
62	Investment—1930—dollars		5,000			229,690		2,008	1,505	320,866	
63	Average, per acre—1930—dollars		250.00			20.74		1.18	12.75	65.04	
64	Maintenance and operation cost per acre—1929—dollars		38.15			2.48		7.87	5.60	13.55	
	Pumped wells—										
65	Investment—1930—dollars					1,460			21,500	9,370	
66	Average, per acre—1930—dollars					2.39			26.35	59.68	
67	Maintenance and operation cost per acre—1929—dollars					0.29			2.09	8.09	

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

TABLE 38.—PUMPING EQUIPMENT, BY KIND OF POWER AND PUMP, AND BY STATES: 1930 AND 1920

ITEM	ENGINES OR MOTORS					PUMPS										
	Capacity		Proportion of total		Increase,[1] 1920–1930	Number		Proportion of total		Increase,[1] 1920–1930	Capacity		Proportion of total		Increase,[1] 1920–1930	Average lift	
	1930	1920	1930	1920		1930	1920	1930	1920		1930	1920	1930	1920		1930	1920
KIND OF POWER	*H. p.*	*H. p.*	*P. ct.*	*P. ct.*	*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*	*G. p. m.*	*G. p. m.*	*P. ct.*	*P. ct.*	*P. ct.*	*Feet*	*Feet*
Total	1,283,419	748,071	100.0	100.0	71.4	61,445	33,804	100.0	100.0	81.8	57,244,859	36,275,005	100.0	100.0	57.8	51	41
Electricity	876,166	289,018	68.3	38.6	203.2	44,165	12,743	71.9	37.7	246.6	37,365,179	13,311,435	65.3	36.7	180.7	57	50
Internal combustion	265,736	259,613	20.7	34.7	2.4	13,012	15,691	21.2	46.4	−17.1	10,891,855	10,461,857	19.0	28.8	4.1	37	35
Steam	37,458	106,568	2.9	14.2	−64.9	332	1,862	0.5	5.5	−82.2	2,827,471	7,526,435	4.9	20.7	−62.4	36	36
Water	12,058	8,093	0.9	1.1	49.0	205	166	0.3	0.5	23.5	400,564	212,346	0.7	0.6	88.6	28	40
Wind	827	10,768	(2)	1.4	−92.3	337	287	0.5	0.8	17.4	17,116	247,445	(2)	0.7	−93.1	50	44
Electricity and—																	
Internal combustion	52,721		4.1			2,587		4.2			2,823,259		4.9			42	
Steam	18,175		1.4			84		0.1			1,515,995		2.6			93	
Wind	1,190		0.1			176		0.3			39,760		(2)			56	
Water	187		(2)			13		(2)			17,651		(2)			80	
Internal combustion and—																	
Steam	8,861		0.7			54		0.1			887,125		1.5			37	
Water	82		(2)			7		(2)			2,860		(2)			27	
Wind	2,019	74,911	0.2	10.0	21.7	293	3,055	0.5	9.0	11.1	58,707	4,515,487	0.1	12.4	27.2	43	46
Steam and water	30		0.1			2		(2)			550		(2)			20	
Water and wind	10		(2)			2		(2)			900		(2)			20	
Electricity, internal combustion, and—																	
Steam	6,820		0.5			50		0.1			364,200		0.6			76	
Wind	268		(2)			28		(2)			8,097		(2)			32	
Not reported	811		(2)			98		0.2			23,570		(2)			60	
KIND OF PUMP																	
Centrifugal	726,301	581,274	56.6	77.0	24.9	34,803	26,019	56.6	77.0	33.8	38,193,371	29,250,062	66.7	80.6	30.6	36	33
Turbine	302,294	24,390	23.6	3.3	------	13,370	677	21.8	2.0	------	8,655,509	525,728	15.1	1.5	------	75	84
Rotary	118,856	36,716	9.3	4.9	223.7	4,816	1,305	7.8	3.9	269.0	3,806,528	2,089,211	6.6	5.8	82.2	63	42
Reciprocating	5,338	32,344	0.4	4.3	−83.5	647	2,729	1.1	8.1	−76.3	133,639	735,362	0.2	2.0	−81.8	80	94
Air lift	1,627	10,072	0.1	1.3	−83.8	85	310	0.1	0.9	−73.4	25,556	304,105	(2)	0.8	−91.6	71	58
Plunger	17,503		1.4			2,807		4.7			272,174		0.5			101	
Screw	8,732		0.7			33		(2)			1,336,253		2.3			16	
Water wheel	285		(2)			117		0.2			25,996		(2)			32	
Bucket	117		(2)			7		(2)			7,050		(2)			13	
Scoop wheel	45		(2)			3		(2)			13,950		(2)			4	
Centrifugal and—																	
Turbine	46,531		3.6			2,287		3.7			1,683,037		2.9			53	
Rotary	12,737		1.0			507		0.8			869,464		1.5			49	
Plunger	3,579		0.3			386		0.6			77,555		0.1			65	
Reciprocating	8,106		0.6			222		0.4			126,704		0.2			86	
Screw	5,288		0.4			30		(2)			794,600		1.4			11	
Air lift	308		(2)			44		0.1			11,355		(2)			33	
Bucket	76		(2)			6		(2)			5,800		(2)			16	
Water wheel	67		(2)			6		(2)			2,710		(2)			22	
Not reported	3,486		0.3			86		0.1			28,462		(2)			148	
Turbine and—																	
Rotary	2,360		0.2			54		0.1			41,116		(2)			85	
Plunger	6,899		0.5			477		0.8			94,241		0.2			104	
Reciprocating	1,227		0.1			43		0.1			14,512		(2)			164	
Screw	125		(2)			4		(2)			2,520		(2)			100	
Air lift	482		(2)			24		(2)			6,595		(2)			85	
Not reported	307		(2)			25		(2)			7,435		(2)			130	
Rotary and—		64,175		8.6	101.0		2,755		8.1	180.4		3,370,537		9.3	90.8	79	57
Plunger	763		(2)			81		0.1			13,485		(2)			133	
Reciprocating	1,550		0.1			37		(2)			20,079		(2)			70	
Screw	45		(2)			2		(2)			1,368		(2)			221	
Air lift	35		(2)			3		(2)			366		(2)			12	
Not reported	2		(2)			2		(2)			30		(2)			50	
Plunger and—																	
Air lift	20		(2)			2		(2)			290		(2)			20	
Water wheel	10		(2)			2		(2)			900		(2)			63	
Not reported	39		(2)			11		(2)			400		(2)			140	
Air lift and bucket	90		(2)			2		(2)			275		(2)				
Centrifugal, turbine, and—																40	
Rotary	45		(2)			3		(2)			1,700		(2)			138	
Plunger	600		(2)			49		0.1			12,680		(2)			60	
Reciprocating	28		(2)			3		(2)			600		1.4			6	
Screw	3,025		0.2			10		(2)			810,000		(2)			37	
Air lift	137		(2)			13		(2)			3,222						
Centrifugal, rotary, and—																70	
Plunger	66		(2)			11		(2)			1,840		(2)			20	
Reciprocating	12		(2)			3		(2)			300		(2)				
Turbine, plunger, and not reported	513		(2)			11		(2)			41,290		0.1			81	
Not reported	3,763		0.3			251		0.4			99,896		0.2			72	
STATE																	
Arizona	57,633	22,014	4.5	2.9	161.8	1,364	1,001	2.2	3.0	36.3	2,125,293	1,048,030	3.7	2.9	102.8	46	44
Arkansas	66,980	58,332	5.2	7.8	14.8	1,206	1,121	2.0	3.3	7.6	1,775,788	1,654,097	3.1	4.6	7.4	68	50
California	820,767	386,200	63.9	51.6	112.5	47,994	24,134	78.1	71.4	98.9	33,240,589	16,773,692	58.1	46.2	98.2	53	41
Colorado	11,204	8,635	0.9	1.2	29.8	540	435	0.9	1.3	24.1	437,250	299,726	0.8	0.8	45.9	25	23
Idaho	33,754	28,364	2.6	3.8	19.0	465	232	0.7	0.7	100.4	2,113,513	1,397,681	3.7	3.9	51.2	32	29
Kansas	6,221	6,946	0.5	0.9	−10.4	312	288	0.5	0.9	8.3	393,526	297,975	0.7	0.8	32.1	26	30
Louisiana	86,413	85,628	6.7	11.4	0.9	2,000	1,941	3.3	5.7	3.0	5,914,799	4,968,686	10.3	13.7	19.0	37	32
Montana	9,095	10,341	0.7	1.4	−12.0	233	299	0.4	0.9	−22.1	523,494	453,231	0.9	1.2	15.5	22	20
Nebraska	10,991	959	0.9	0.1	------	636	54	1.0	0.2	------	536,752	73,686	0.9	0.2	628.4	29	24
Nevada	2,671	409	0.2	(2)	553.1	173	72	0.3	0.2	140.3	115,648	35,266	0.2	(2)	227.9	31	22
New Mexico	14,483	8,488	1.1	1.1	70.6	738	491	1.2	1.5	50.3	555,063	304,789	1.0	0.8	82.1	40	40
North Dakota	216	2,068	(2)	0.3	−89.6	13	10	(2)	(2)	30.0	24,900	51,250	(2)	0.1	−51.4	24	38
Oklahoma	229	184	(2)	(2)	24.5	30	26	(2)	(2)	15.4	8,855	7,668	(3)	(2)	15.5	33	59
Oregon	21,257	13,769	1.6	1.8	54.4	1,157	614	1.9	1.8	88.4	1,022,213	600,045	1.8	1.7	70.4	27	28
South Dakota	92	498	(2)	(2)	−81.5	8	25	(2)	(2)	−68.0	4,027	23,320	(2)	(3)	−82.7	27	21
Texas	95,933	80,511	7.5	10.7	19.2	2,028	1,641	3.3	4.9	23.6	6,494,999	6,825,998	11.3	18.8	−4.8	55	45
Utah	11,381	11,392	0.9	1.5	−0.1	460	291	0.7	0.9	58.1	877,942	783,588	1.5	2.2	12.0	36	25
Washington	33,187	22,929	2.6	3.1	44.7	2,023	1,059	3.3	3.1	91.0	993,303	636,552	1.7	1.8	56.0	59	60
Wyoming	912	1,304	(2)	0.2	−30.1	65	70	0.1	0.2	−7.1	86,905	39,725	0.2	0.1	118.8	21	31

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

[2] Less than one-tenth of 1 per cent.

TABLE 39.—NUMBER AND CAPACITY OF PUMPED WELLS, BY STATES: 1930 AND 1920

STATE	PUMPED WELLS							
	Number		Increase,[1] 1920–1930		Capacity		Increase,[1] 1920–1930	
	1930	1920	Number	Per cent	1930	1920	Number	Per cent
					G. p. m.	*G. p. m.*	*G. p. m.*	
Total (18 States [2])	56,729	32,094	24,635	76.8	32,467,120	16,396,549	16,070,571	98.0
Arizona	1,398	999	399	39.9	1,832,352	1,042,590	789,762	75.8
Arkansas	1,190	1,089	101	9.3	1,641,448	1,470,147	171,301	11.7
California	46,737	25,401	21,336	84.0	24,266,167	10,608,476	13,657,691	128.8
Colorado	654	527	127	24.1	237,903	210,094	27,809	13.2
Idaho	121	53	68	128.3	34,601	17,749	16,852	94.9
Kansas	772	710	62	8.7	323,500	266,797	56,703	21.3
Louisiana	1,389	812	577	71.1	1,958,811	1,607,637	351,174	21.8
Montana	49	22	27	122.7	18,653	11,085	7,568	68.3
Nebraska	537	34	503		428,058	24,701	403,357	
Nevada	147	129	18	14.0	54,162	6,798	47,364	696.7
New Mexico	680	461	219	47.5	481,898	265,618	216,280	81.4
Oklahoma	18	19	−1	−5.3	2,715	3,643	−928	−25.5
Oregon	558	208	350	168.3	136,669	47,026	89,643	190.6
South Dakota	1	1			375	800	−425	−53.1
Texas	1,102	901	201	22.3	614,395	538,565	75,830	14.1
Utah	346	192	154	80.2	120,333	39,059	81,274	208.1
Washington	1,019	520	499	96.0	306,800	227,744	79,056	34.7
Wyoming	11	16	−5	−31.3	8,280	8,020	260	3.2

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

[2] None reported for North Dakota.

TABLE 40.—NUMBER AND CAPACITY OF PUMPING PLANTS AND PUMPS, BY CHARACTER OF ENTERPRISE: 1930 AND 1920

CHARACTER OF ENTERPRISE	PUMPING PLANTS									
	1930		1920		Increase 1920–1930[1]	1930		1920		Increase 1920–1930[1]
	Number	Proportion of total	Number	Proportion of total		Engine or motor capacity	Proportion of total	Engine or motor capacity	Proportion of total	
		Per cent		*Per cent*	*Per cent*	*H. p.*	*Per cent*	*H. p.*	*Per cent*	*Per cent*
Total	59,344	100.0	29,458	100.0	101.5	1,283,419	100.0	748,971	100.0	71.4
Individual and partnership	56,387	95.0	28,336	96.2	99.0	939,008	73.1	537,381	71.6	74.7
Cooperative	1,189	2.0	752	2.6	58.1	111,296	8.7	82,963	11.1	34.2
Irrigation district	810	1.4	103	0.3	686.4	108,004	8.4	43,394	5.8	148.9
Carey Act			1	(2)	−100.0			746	0.1	−100.0
Commercial	452	0.7	188	0.6	140.4	73,421	5.7	66,409	8.9	10.6
United States Bureau of Indian Affairs	103	0.2	14	(2)	635.7	7,317	0.6	733	0.1	898.2
United States Bureau of Reclamation	198	0.3	15	0.1		30,577	2.4	14,423	1.9	112.0
State	72	0.1	16	0.1	350.0	2,160	0.2	416	0.1	419.2
City	103	0.2	18	0.1	472.2	5,141	0.4	2,225	0.3	131.1
Other	30	0.1	15	0.1	100.0	6,495	0.5	281	(2)	

CHARACTER OF ENTERPRISE	PUMPS									
	1930		1920		Increase 1920–1930[1]	1930		1920		Increase 1920–1930[1]
	Number	Proportion of total	Number	Proportion of total		Capacity	Proportion of total	Capacity	Proportion of total	
		Per cent		*Per cent*	*Per cent*	*G. p. m.*	*Per cent*	*G. p. m.*	*Per cent*	*Per cent*
Total	61,445	100.0	33,804	100.0	81.8	57,244,859	100.0	36,275,005	100.0	57.8
Individual and partnership	57,803	94.1	31,564	93.4	83.1	36,661,720	64.1	22,563,649	62.2	62.5
Cooperative	1,494	2.4	1,252	3.7	19.3	4,312,711	7.5	3,515,742	9.7	22.7
Irrigation district	1,077	1.8	312	0.9	245.2	7,233,209	12.6	1,837,264	5.1	293.7
Carey Act			25	0.1	−100.0					
Commercial	573	0.9	464	1.4	23.5	4,922,912	8.6	6,814,220	18.8	−27.8
United States Bureau of Indian Affairs	46	0.1	25	0.1	84.0	262,723	0.5	87,243	0.2	201.1
United States Bureau of Reclamation	232	0.4	84	0.2	176.2	1,896,587	3.3	973,170	2.7	94.9
State	81	0.1	21	0.1	285.7	76,617	0.1	60,810	0.2	26.0
City	94	0.1	40	0.1	135.0	1,007,480	1.8	411,722	1.1	144.7
Other	45	0.1	17	0.1	164.7	870,900	1.5	11,185	(2)	

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

[2] Less than one-tenth of 1 per cent.

TABLE 41.—NUMBER AND CAPACITY OF PUMPING PLANTS AND PUMPS, BY DATE OF BEGINNING OF ENTERPRISE: 1930 AND 1920

DATE OF BEGINNING OF ENTERPRISE	PUMPING PLANTS									
	1930		1920		Increase 1920–1930 [1]	1930		1920		Increase 1920–1930 [1]
	Number	Proportion of total	Number	Proportion of total		Engine or motor capacity	Proportion of total	Engine or motor capacity	Proportion of total	
Total	59,344	*Per cent* 100.0	29,458	*Per cent* 100.0	*Per cent* 101.5	*H. p.* 1,283,419	*Per cent* 100.0	*H. p.* 748,971	*Per cent* 100.0	*Per cent* 71.4
Before 1860	89	0.1	46	0.2	93.5	4,456	0.4	684	0.1	551.5
1860–1869	72	0.1	43	0.1	67.4	1,359	0.1	574	0.1	136.8
1870–1879	105	0.2	83	0.3	26.5	7,664	0.6	3,697	0.5	107.3
1880–1889	338	0.6	290	1.0	16.6	22,712	1.8	14,938	2.0	52.0
1890–1899	623	1.1	668	2.3	−6.7	39,074	3.1	37,387	5.0	4.5
1900–1904	916	1.6	1,455	4.9	−37.0	39,607	3.1	59,286	7.9	−33.2
1905–1909	1,911	3.2	2,898	9.8	−34.1	108,307	8.4	98,729	13.2	9.7
1910–1914	5,602	9.4	9,468	32.1	−40.8	151,797	11.8	226,748	30.3	−33.1
1915–1919	6,961	11.7	10,469	35.5	−33.5	182,727	14.2	242,629	32.4	−24.7
1920–1924	8,258	13.9				171,067	13.3			
1925–1929	11,551	19.5				218,037	17.0			
Not reported	22,918	38.6	4,038	13.7	467.6	336,612	26.2	64,299	8.6	423.5

DATE OF BEGINNING OF ENTERPRISE	PUMPS									
	1930		1920		Increase 1920–1930 [1]	1930		1920		Increase 1920–1930 [1]
	Number	Proportion of total	Number	Proportion of total		Capacity	Proportion of total	Capacity	Proportion of total	
Total	61,445	*Per cent* 100.0	33,804	*Per cent* 100.0	*Per cent* 81.8	*G. p. m.* 57,244,859	*Per cent* 100.0	*G. p. m.* 36,275,005	*Per cent* 100.0	*Per cent* 57.8
Before 1860	101	0.2	55	0.2	83.6	90,063	0.2	28,073	0.1	220.8
1860–1869	78	0.1	44	0.1	77.3	74,345	0.1	43,439	0.1	71.1
1870–1879	115	0.2	108	0.3	6.5	818,006	1.4	86,287	0.2	848.0
1880–1889	373	0.6	407	1.2	−8.4	1,292,116	2.3	1,476,530	4.1	−12.5
1890–1899	714	1.1	862	2.5	−17.2	2,719,256	4.7	4,378,623	12.1	−37.9
1900–1904	990	1.6	1,741	5.2	−43.1	2,956,984	5.2	3,706,532	10.2	−20.2
1905–1909	2,075	3.4	3,492	10.3	−40.6	5,384,338	9.4	4,379,501	12.1	22.9
1910–1914	5,940	9.7	10,867	32.1	−45.3	5,946,919	10.4	8,316,741	22.9	−28.5
1915–1919	7,216	11.7	11,713	34.6	−38.4	9,503,745	16.6	10,663,654	29.4	−10.9
1920–1924	8,468	13.8				6,642,094	11.6			
1925–1929	11,968	19.5				8,066,589	14.1			
Not reported	23,407	38.1	4,515	13.4	418.4	13,750,404	24.0	3,195,625	8.8	330.3

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

TABLE 42.—NUMBER AND CAPACITY OF PUMPED WELLS, BY DATE OF BEGINNING OF ENTERPRISE: 1930 AND 1920

DATE OF BEGINNING OF ENTERPRISE	PUMPED WELLS					CAPACITY				
	1930		1920		Increase 1920–1930 [1]	1930		1920		Increase 1920–1930 [1]
	Number	Proportion of total	Number	Proportion of total		Gallons per minute	Proportion of total	Gallons per minute	Proportion of total	
Total	56,729	*Per cent* 100.0	32,094	*Per cent* 100.0	*Per cent* 76.8	32,467,120	*Per cent* 100.0	16,396,549	*Per cent* 100.0	*Per cent* 98.0
Before 1860	75	0.1	37	0.1	102.7	60,937	0.2	19,028	0.1	220.2
1860–1869	54	0.1	79	0.2	−31.6	24,573	0.1	38,909	0.2	−36.8
1870–1879	82	0.1	82	0.3		68,299	0.2	46,174	0.3	47.9
1880–1889	260	0.5	327	1.0	−20.5	177,612	0.5	144,329	0.9	22.6
1890–1899	610	1.1	846	2.6	−27.9	430,994	1.3	400,373	2.4	7.6
1900–1904	794	1.4	1,591	5.0	−50.1	452,875	1.4	745,045	4.5	−39.2
1905–1909	1,704	3.0	3,304	10.3	−48.4	1,320,961	4.1	1,741,309	10.6	−24.1
1910–1914	5,371	9.5	10,467	32.6	−48.7	3,146,633	9.7	5,436,719	33.2	−42.1
1915–1919	6,623	11.7	10,971	34.2	−39.6	4,276,141	13.2	5,861,661	35.7	−27.0
1920–1924	7,902	13.9				4,567,304	14.1			
1925–1929	10,829	19.1				6,279,295	19.3			
Not reported	22,425	39.5	4,390	13.7	410.8	11,661,496	35.9	1,962,502	12.0	494.2

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

TABLE 43.—NUMBER AND CAPACITY OF PUMPED WELLS, BY CHARACTER OF ENTERPRISE: 1930 AND 1920

CHARACTER OF ENTERPRISE	PUMPED WELLS					CAPACITY				
	1930		1920		Increase 1920–1930 [1]	1930		1920		Increase 1920–1930 [1]
	Number	Proportion of total	Number	Proportion of total		Gallons per minute	Proportion of total	Gallons per minute	Proportion of total	
Total	50,729	*Per cent* 100.0	32,094	*Per cent* 100.0	*Per cent* 76.8	32,467,120	*Per cent* 100.0	16,396,540	*Per cent* 100.0	*Per cent* 98.0
Individual and partnership	53,998	95.2	30,415	94.8	77.5	29,301,036	90.2	14,953,276	91.2	96.0
Cooperative	1,100	1.9	1,082	3.4	1.7	873,092	2.7	1,014,138	6.2	−13.9
Irrigation district	763	1.3	100	0.3	663.0	1,006,612	3.1	93,770	0.6	973.5
Commercial	424	0.7	298	0.9	42.3	642,082	2.0	235,272	1.4	172.9
United States Bureau of Indian Affairs	108	0.2	72	0.2	50.0	121,463	0.4	7,268	[2]	
United States Bureau of Reclamation	180	0.3	49	0.2	267.3	380,000	1.2	46,000	0.3	726.1
State	54	[2]	34	0.1	58.8	34,855	0.1	9,636	0.1	261.7
City	101	0.2	32	0.1	215.6	107,080	0.3	27,619	0.2	287.7
Other	1	[2]	12	[2]	−91.7	900	[2]	9,570	0.1	−90.6

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

[2] Less than one-tenth of 1 per cent.

QUANTITY OF WATER USED

The schedules on which the larger enterprises reported in the Fifteenth Census called for the average volume of water entering canals in second-feet; the total quantity of water entering the canals in acre-feet; and the total quantity of water delivered to irrigators in acre-feet. These inquiries were 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, except when actual dates of service were given. Some enterprises reported quantities entering canals, but not quantities delivered; others gave the latter information but not the former. However, the areas irrigated by the enterprises reporting either or both of these quantities were large enough to produce reliable averages, which are summarized in Table 44.

TABLE 44.—WATER USED, BY STATES, 1929

STATE	TOTAL			MEASURED			NOT MEASURED		
	Area irrigated per second-foot of water entering canals	Quantity of water entering canals per acre irrigated	Quantity of water delivered to irrigators per acre irrigated	Area irrigated per second-foot of water entering canals	Quantity of water entering canals per acre irrigated	Quantity of water delivered to irrigators per acre irrigated	Area irrigated per second-foot of water entering canals	Quantity of water entering canals per acre irrigated	Quantity of water delivered to irrigators per acre irrigated
Average (16 States [1])	*Acres* 71	*Acre-feet* 4.1	*Acre-feet* 2.8	*Acres* 74	*Acre-feet* 4.0	*Acre-feet* 2.8	*Acres* 59	*Acre-feet* 4.4	*Acre-feet* 2.6
Arizona	84	5.8	3.1	85	5.7	2.9	74	7.8	5.3
California	90	4.0	2.8	94	4.0	2.7	63	3.6	3.2
Colorado	92	2.8	1.8	100	2.4	1.8	53	3.8	2.1
Idaho	49	5.9	4.1	49	5.5	4.1	52	7.2	4.9
Louisiana	41	2.8	1.6	[2]	[2]	[2]	41	2.8	1.6
Montana	57	4.3	1.7	62	3.2	1.6	52	5.2	1.8
Nebraska	66	4.1	3.0	65	4.2	3.1	112	1.8	1.8
Nevada	107	4.0	3.1	109	4.0	3.1	71	4.6	3.2
New Mexico	54	5.8	2.1	51	6.2	2.1	57	5.3	1.4
North Dakota	61	6.1	1.6	61	6.1	1.6	[2]	[2]	[2]
Oregon	55	4.8	3.1	55	5.2	3.2	56	4.1	2.3
South Dakota	75	3.8	1.3	82	3.6	[2]	36	5.9	1.3
Texas	103	3.3	1.7	100	4.8	2.6	105	2.5	1.5
Utah	82	3.5	2.4	90	2.7	2.4	61	4.5	2.6
Washington	65	5.4	3.6	68	5.3	3.6	38	5.9	3.5
Wyoming	60	3.2	2.5	68	2.8	2.0	53	3.5	3.4

[1] Not reported for Arkansas, Kansas, and Oklahoma.

[2] Not reported.

The schedules showed whether the water was measured, and the reports representing measurements and those representing estimates were tabulated separately. Again, some enterprises reported measurements at the intakes of their canals, but gave estimates for quantities delivered, or vice versa. It is the practice of some enterprises to deliver water to individual farms and measure it at the farmer's head gate, but other enterprises deliver only to laterals which serve several farms. The schedules included a question preceding that calling for the quantity delivered to irrigators, reading as follows: "Average head of water delivered per individual irrigator (cubic feet per second)," the intent of the inquiry being to produce information indicating the quantities of water actually applied to the land. This intent appears to have been generally understood.

However, the figures representing measurements are the more reliable, not only because of their nature but also because they represent large proportions of the irrigated areas reporting. They show for 1929 an average of 4 acre-feet entering canals per acre irrigated and 2.8 acre-feet delivered per acre irrigated, the quantity delivered being 70 per cent of the quantity entering canals. The same canals are not in all cases represented in this comparison; the figures never-

theless reflect the results of efforts made in recent years by many of the larger enterprises to reduce losses of water in transit in their canals, as the proportionate loss or wastage is somewhat lower than that previously reported. Enterprises in Utah which measured the water they used in 1929, conveyed it most economically, the apparent loss being only 11 per cent. The irrigated acreage reporting delivery measurements was only 136,414 acres, however, as compared with 517,459 acres reporting diversion measurements. Approximate conveyance losses for the other States in percentages based on reported measurements, are as follows: Nevada, 22; Idaho, 25; Nebraska, 26; Wyoming, 28; Washington, 32; California, 32; Colorado, 25; Oregon, 39; Texas, 46; Arizona, 49; Montana, 50; New Mexico, 66; and North Dakota, 74.

The highest 1929 gross duty of water reported (i. e., the largest acreage irrigated per second-foot of water entering canals), based on acreage reporting measurements, is that for Nevada, 107 acres per second-foot. Consideration of this figure should, however, take into account the severe shortage of water which handicapped Nevada irrigators in 1929; they used what water was available, which was not always what their crops needed.

DRAINAGE OF IRRIGATED LAND

In many sections the continuance of irrigation, especially where the water supply is so liberal as to permit its wasteful use, eventually leads to the necessity to drain such tracts as do not have adequate natural drainage. Questions were asked in the 1920 census, and repeated in 1930, to ascertain the extent not only of the damage caused by faulty irrigation but also of the areas served by corrective drainage systems.

Summary Table 15 (page 57) shows that 3,853 irrigation enterprises in 1930 reported land either drained or needing drainage. In the 1920 census, 3,068 enterprises reported similarly. Thus only approximately 5 per cent of all irrigation enterprises include lands which have been reclaimed by drainage or which need such reclamation. Table 45 shows, however, that in 1930 the irrigable area of the 3,853 enterprises so reporting was approximately one-third the irrigable area of all irrigation enterprises; the area of the land for which drains had been installed was nearly 15 per cent of the area existing enterprises were capable of supplying with water, and 18 per cent of the area irrigated in 1929; while the additional area estimated to need drainage was nearly 5 per cent of the area enterprises were capable of supplying and more than 5 per cent of the irrigated area. Compared with the irrigable area in the enterprises reporting lands drained or needing drainage, the area for which drains had been installed was approximately 35 per cent, while the additional area needing drainage was approximately 10 per cent.

The increase of 2,187,501 acres in the area for which drains have been installed has been accompanied with a reduction of the additional area needing drainage of 398,205 acres. All States except New Mexico and Utah show increases in the area for which drains have been installed, and all except Montana, Nebraska, North Dakota, Oregon, and South Dakota show reductions in the additional area needing drainage.

Relatively few of the smaller irrigation enterprises reported either accomplished or needed drainage of lands within their borders, for the reason that drainage systems serving irrigated lands are usually built by some form of community effort and drain large units. In some cases such drainage is accomplished by the irrigation enterprises themselves, but in many instances the drainage systems are built and operated by enterprises entirely separate from the irrigation enterprises containing the affected lands. Hence the figures shown in Table 45, representing both area for which drains have been installed and additional area needing drainage, are made up largely of estimates by the reporting irrigation enterprises. They compare closely, however, with the more detailed figures obtained in the census of drainage.

TABLE 45.—AREA WITHIN IRRIGATION ENTERPRISES FOR WHICH DRAINS HAVE BEEN INSTALLED AND ADDITIONAL AREA IN NEED OF DRAINAGE, BY STATES: 1930 AND 1920

STATE	AREA[1] IN ENTERPRISES REPORTING LAND DRAINED OR NEEDING DRAINAGE		AREA FOR WHICH DRAINS HAVE BEEN INSTALLED				ADDITIONAL AREA NEEDING DRAINAGE			
	1930	1920	1930	1920	Increase,[2] 1920–1930		1930	1920	Increase,[2] 1920–1930	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Per cent*	*Acres*	*Acres*	*Acres*	*Per cent*
Total (19 States)	10,611,415	8,860,760	3,707,354	1,519,853	2,187,501	143.9	1,078,566	1,476,771	−398,205	−27.0
Arizona	568,254	382,928	123,013	25,173	97,840	388.7	47,155	71,357	−24,202	−33.9
Arkansas	124,799	37,574	107,601	27,350	80,251	293.4	1,873	2,821	−948	−33.6
California	3,105,549	1,623,330	1,522,338	319,573	1,202,765	376.4	235,990	409,933	−173,943	−42.4
Colorado	1,018,260	1,520,311	215,600	113,899	101,701	89.3	148,693	220,711	−72,018	−32.6
Idaho	920,314	734,405	202,575	81,187	121,388	149.5	48,995	94,934	−45,939	−48.4
Kansas	651	3,610	336	250	86	34.4	157	1,320	−1,163	−88.1
Louisiana	226,510	283,476	169,577	167,138	2,439	1.5	18,832	21,202	−2,370	−11.2
Montana	840,007	751,274	85,189	62,872	22,317	35.5	59,995	50,901	9,094	17.9
Nebraska	434,969	376,518	122,101	10,793	111,308		51,505	26,606	24,899	93.6
Nevada	353,238	537,417	126,249	34,175	92,074	269.4	26,348	98,249	−71,901	−73.2
New Mexico	225,730	212,353	60,907	74,783	−13,876	−18.6	49,572	60,277	−10,705	−17.8
North Dakota	20,359	49,681	3,040	1,613	1,427	88.5	2,000	659	1,341	203.5
Oklahoma	189	1,960	95		95		50	1,820	−1,770	−97.3
Oregon	436,425	347,750	230,413	93,799	136,614	145.6	94,866	46,115	48,751	105.7
South Dakota	79,729	106,129	4,353	2,109	2,244	106.4	6,100	4,714	1,386	29.4
Texas	814,833	650,822	345,926	272,437	73,489	27.0	135,936	154,532	−18,596	−12.0
Utah	388,697	503,212	68,656	85,448	−16,792	−19.7	88,338	91,976	−3,638	−4.0
Washington	460,861	218,763	172,039	79,168	92,871	117.3	28,084	43,461	−15,377	−35.4
Wyoming	592,041	513,347	147,346	68,086	79,260	116.4	34,077	75,183	−41,106	−54.7

[1] Irrigable area, 1930; total area, 1920.

[2] A minus sign (−) denotes decrease. Per cent not shown when more than 1,000.