

UNITED STATES DEPARTMENT OF COMMERCE

JESSE H. JONES, Secretary

BUREAU OF THE CENSUS

J. C. CAPT, Director (Appointed May 22, 1941)

WILLIAM LANE AUSTIN, Director (Retired January 31, 1941)

PHILIP M. HAUSER, Assistant Director

HOWARD H. McCLURE, Assistant Director



SIXTEENTH CENSUS OF THE UNITED STATES: 1940

IRRIGATION OF AGRICULTURAL LANDS

**Irrigation Enterprises, Areas, Irrigation Works,
Investment, Indebtedness, Maintenance and
Operation, Water Used, Pay Roll and Employees,
and Irrigated Crops, With Detailed Statistics for
Drainage Basins and Counties, and Summaries
for States and the United States**

Prepared under the supervision of

ZELLMER R. PETTET

Chief Statistician for Agriculture

**UNITED STATES
GOVERNMENT PRINTING OFFICE
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Vital Statistics—HALBERT L. DUNN, *Chief Statistician.*

LETTER OF TRANSMITTAL

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
Washington, D. C., November 5, 1942

SIR:

I transmit herewith the volume on Irrigation of Agricultural Lands of the Sixteenth Decennial Census. This report contains detailed statistics for drainage basins and counties with summaries for the States and the United States. State reports, contained in this volume, were first published as separate bulletins.

Provision for the 1940 Census of Irrigation was made in the Act providing for the Fifteenth Decennial Census which was approved on June 18, 1929. Through the medium of mail and field canvasses, returns were obtained from all types of irrigation enterprises, except enterprises of the United States Government which were reported directly to the Bureau of the Census.

The collection and compilation of these statistics and the preparation of this volume were made under the supervision of Z. R. Pettet, Chief Statistician for Agriculture, with the assistance of Sherman S. Slick, Assistant Chief Statistician, and Milo B. Williams, Principal Irrigation Engineer. Much helpful aid was furnished by other members of the Division of Agriculture. The graphic material was prepared under the supervision of Clarence E. Batschelet, Geographer of the Census.

Acknowledgment is made also of the assistance and cooperation of Paul A. Ewing, Irrigation Economist, U. S. Department of Agriculture, who acted in a consultant capacity; Wells A. Hutchins, Senior Irrigation Economist, Soil Conservation Service, U. S. Department of Agriculture; G. W. Lineweaver, Chief of Research Section, Bureau of Reclamation; Department of the Interior; and of the Division of Statistical Standards, Bureau of the Budget.

Respectfully,

J. C. CAPT,
Director of the Census.

Hon. JESSE H. JONES,
Secretary of Commerce

III

SIXTEENTH CENSUS OF THE UNITED STATES: 1940

REPORTS ON AGRICULTURE, IRRIGATION, AND DRAINAGE

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Part 1.—New England, Middle Atlantic, and
East North Central States
2.—West North Central States
3.—South Atlantic States

Part 4.—East South Central States
5.—West South Central States
6.—Mountain and Pacific States

Volume II.—Statistics by Counties for Value of Farm Products, Farms Classified by Major Source of Income, and Farms Classified by Total Value of Products.

Part 1.—Northern States

Part 2.—Southern States

Part 3.—Western States

Volume III.—General Report—Statistics by Subjects for the United States, Geographic Divisions, and States.

Chapter I.—Farms and Farm Property
II.—Size of Farms
III.—Color, Tenure, and Race of
Farm Operators
IV.—Farm Mortgages and Farm
Taxes
V.—Work Off Farm, Age, and
Years on Farm

Chapter VI.—Cooperation, Labor, Expenditures,
Machinery, Facilities, and
Residence
VII.—Livestock and Livestock Products
VIII.—Field Crops and Vegetables
IX.—Fruits and Nuts and
Horticultural Specialties
X.—Value of Farm Products

United States Summary Bulletins.—Statistics for the United States, Geographic Divisions, and States in condensed form as follows:

First Series Summary—Number of Farms, Uses of Land, Values, Principal Classes of Livestock and Livestock Products; and Specified Crops Harvested.

Second Series Summary—Farm Mortgages, Taxes, Labor, Expenditures, and Miscellaneous Farm Information; Goats and Mohair; and Fruits, Vegetables, and Minor Crops.

Third Series Summary—Value of Farm Products, Farms Classified by Major Source of Income, and Farms Classified by Total Value of Products.

Special Poultry Report.—Statistics by Geographic Divisions and States for Poultry of All Kinds on Hand and Raised; by Counties for Chickens and Chicken Egg Production by Number of Chickens on Hand; and by Counties for Farms Reporting Chickens and Turkeys Raised by Numbers Raised (one volume).

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Territories and Outlying Possessions.—Farms and Farm Property, Livestock and Livestock Products, and Crops (one volume). (Separate agricultural bulletins are available for Hawaii and Puerto Rico).

Territories:
Alaska
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Puerto Rico

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American Samoa
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Virgin Islands of the United States

Irrigation of Agricultural Lands.—Statistics by Drainage Basins and by Counties for 20 Irrigation States and a Summary for the United States (one volume).

Twenty Separate State Maps Showing Irrigation by Drainage Basins.
A Separate Composite Map Showing Irrigation by Drainage Basins.

Drainage of Agricultural Lands.—Statistics for 38 Drainage States with County Data for 36 States and a summary for the United States (one volume).

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ITEM	Arizona	Arkansas	California	Colorado	Florida ¹	Idaho	Kansas	Louisiana	Montana	Nebraska	Nevada	New Mexico	No. Dakota	Oklahoma	Oregon	So. Dakota	Texas	Utah	Washington	Wyoming
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Census of Agriculture—Number of farms, farm acreage according to use, and specified farm values for irrigated and nonirrigated farms, by tenure of operator, 1940-----	92	116	132	184	668	232	270	292	312	354	384	414	444	458	474	510	528	566	600	630
Number of enterprises, irrigable area, area works were capable of supplying with water, 1940; irrigated area, 1939, 1929, and 1919; water delivered to irrigators, 1939; by source of water supply-----	93	117	133	185	669	233	271	293	313	355	385	415	445	459	475	511	529	567	601	631
Investment, 1940 and 1930; and cost of maintenance and operation, 1939, 1929, and 1919; by source of water supply-----	93	117	133	185	669	233	271	293	313	355	385	415	445	459	475	511	529	567	601	631
Areas, by type of enterprise: 1940, 1930, and 1920-----	94	118	134	186	670	234	272	294	314	356	386	416	446	460	476	512	530	568	602	632
Enterprises, areas, average costs, 1940; and area irrigated, 1939; by type of enterprise-----	94	118	134	186	669	234	272	294	314	356	386	416	446	460	476	512	530	568	602	632
Investment in irrigation enterprises, by type of enterprise: 1940, 1930, and 1920-----	94	118	134	186	669	234	272	294	314	356	386	416	446	460	476	512	530	568	602	632
Indebtedness, arrearage, and charges, by type of enterprise, Census of 1940-----	95	118	135	187	---	235	273	295	315	357	387	417	447	461	477	513	531	569	603	633
Cost of maintenance and operation, and pay roll and number of employees, 1939; by type of enterprise-----	95	119	135	187	669	235	273	295	315	357	387	417	447	461	477	513	531	569	603	633
Irrigation works, by type of enterprise, 1940-----	95	119	135	187	670	235	273	295	315	357	387	417	447	461	477	513	531	569	603	633
Dams, by material: 1940 and 1930-----	96	119	136	188	671	236	274	296	316	358	388	418	448	461	478	514	532	570	604	634
Pumping plants, by kind of motive power and type of pump, 1940; and total number and capacity, 1930-----	96	119	136	188	670	236	274	296	316	358	388	418	448	462	478	514	532	570	604	634
Pipe lines, by material, size, and length: 1940 and 1930-----	96	120	136	188	671	236	274	296	316	358	388	418	448	462	478	514	532	570	604	634
Area within irrigation enterprises for which drains have been installed, and additional area in need of drainage: 1940, 1930, and 1920-----	96	120	136	189	671	236	275	296	316	358	388	418	448	462	478	515	533	570	604	635
Water used, by source of supply: 1939, 1929, and 1919-----	97	120	137	189	671	237	275	297	317	359	389	419	449	463	479	515	533	571	605	635
Area irrigated, by type of rights under which water was delivered: 1939, 1929, and 1919-----	97	---	137	189	---	237	275	---	317	359	389	419	449	463	479	515	533	571	605	635
Enterprises, area irrigated, capital invested, maintenance and operation, charges, indebtedness and arrearage, type of enterprise, pay roll, number of employees, and source of water supply; by specified groups of irrigated farms, areas irrigated, and cost of works: Census of 1940-----	98	121	138	190	672	238	276	298	318	360	390	420	450	464	480	516	534	572	606	636
Climatological influence on water supplies, 1939-----	100	123	140	192	672	240	278	297	320	362	392	422	450	464	482	519	536	574	608	638
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Enterprises and irrigation works, 1940, 1930, and 1920-----	107	126	160	207	675	252	282	303	332	368	402	430	453	468	494	522	542	585	616	652
COUNTY TABLES:																				
Irrigated farms and tenure of farm operators, 1940 and 1930; irrigated area, 1939, 1929, and 1919; irrigable area and capital invested, 1940, 1930, and 1920; maintenance and operation, charges, and indebtedness, 1939 and 1929; land in irrigated farms, 1940; water delivered to irrigators and drainage of irrigated land, 1939-----	111	128	170	216	676	259	284	306	340	370	408	436	454	470	502	524	544	592	620	660
Farm values, 1940; enterprises and irrigation works, 1940, 1930, and 1920; and pay roll and number of employees, 1939-----	114	130	178	226	679	266	288	309	348	378	411	440	458	472	506	526	556	597	625	665

¹The Census of Irrigation included Florida for the first time in 1940. The table titles herewith are not always applicable.

INTRODUCTION

(Section A)

SUMMARY FOR THE UNITED STATES

Milo B. Williams, *Principal Irrigation Engineer*
Paul A. Ewing, *Consultant*

INTRODUCTION

History of the Census of Irrigation.—Inquiries relating to irrigation were first made for the Eleventh Decennial Census taken in 1890 by the Bureau of the Census in 16 western States. These statistics were published in a separate report, "Agriculture by Irrigation in the Western Part of the United States." The Twelfth Decennial Census taken in 1900 included, as a part of the Census of Agriculture, irrigation inquiries in the same 16 States and these statistics were included in the State reports of the Census of Agriculture. A special Census of Irrigation was taken in 1902 and the statistics were published in Bulletin No. 16, of the Bureau of the Census, 1904. An irrigation census was taken as a part of the Census of Agriculture in the years of 1910, 1920, 1930, and 1940 and the data published for each Irrigation Census as separate reports. An inquiry relating to irrigated cropland harvested was also included in the middecennial Census of Agriculture in 1935, but these data were published in the Agriculture Reports for that year.

Presentation of statistics.—This volume presents statistics for irrigation in the United States collected by the Bureau of the Census in 1940 and shows some comparable data from the Irrigation Censuses of 1890, 1900, and 1910 and to a greater degree for 1920 and 1930.

Included are a summary for the United States and reprints of statistics for the 20 States where an Irrigation Census was taken on special schedules in 1940. These State reports were first presented in 18 separate bulletins (data for the States of Arkansas and Oklahoma were combined in one bulletin and those for North Dakota and South Dakota in another) entitled "Irrigation of Agricultural Lands." In addition to the statistics obtained on the special irrigation schedules, data are also shown for all States as obtained on the Farm and Ranch Schedule in the Agricultural Census.

Statistics for 17 western States and Arkansas and Louisiana are summarized as one group, and the less extensive statistics for the remaining 29 States are presented as a second group to represent the more humid portion of the United States. Although a special schedule was used for the 1940 Irrigation Census in Florida, the statistics for this State are summarized with the humid group as there are no historic data to present, comparable to the data for the 19 States in the western portion of the United States.

The following textual matter relates to the tabulations presented in this volume.

Method of collecting information.—The plan followed in both the Fifteenth and Sixteenth Decennial Censuses for the canvass of irrigation enterprises involved the use of two schedules designated as Irrigation-1 and Irrigation-2. The simpler of these schedules, or Irrigation-1, was used by the enumerators engaged in the canvass of population and agriculture to obtain reports of individual, partnership, and cooperative enterprises serving 1 to 4 farms. The more elaborate, or Irrigation-2, schedule was used in a preliminary canvass by mail, which was followed by a field canvass by special irrigation technicians. Through the medium of the mail and field canvasses reports were obtained from all types of irrigation enterprises serving 5 or more farms, except Government enterprises which were reported direct to the Bureau of the Census by the Commissioner of the Bureau of Reclamation and the Commissioner of the Office of Indian Affairs, the separate reports being prepared by local division or project engineers under the supervision of these officials.

Census dates.—The dates of the Sixteenth and Fifteenth Decennial Censuses were as of April 1, 1940 and 1930, respectively, while the date of the Fourteenth Decennial Census was as of January 1, 1920. The change of date did not affect the comparison interval of 10 years used in this report because, in general, the statistics of farms, areas irrigated, crops grown under irrigation, and amounts and costs of water related to the calendar years preceding the years of enumeration. The statistics of acreages to which existing works were capable of supplying water related to the year in which the enumeration was made, and the statistics of capital investment were as of December 31 of the preceding year, thus also retaining the comparative interval of exactly 10 years. Enterprises which began to operate after January 1, 1940 were not included in the Sixteenth Decennial Census enumeration.

Scope of the Census of Irrigation.—The basic inquiries in the irrigation census of 1940 were similar to those made in previous censuses; namely, (1) the type of the irrigation enterprises as indicated by the character of their organizations, (2) the areas of irrigable lands in enterprises and under irrigation, (3) the physical structures used in diverting, lifting, storing, and distributing irrigation water to farms, and (4) the capital investment of irrigation enterprises. Supplemental inquiries were also made regarding other phases of irrigation, such as source of water supply, number of farms irrigated in 1939, type of water rights, drainage of irrigated lands, capacity of irrigation works and the annual cost of their maintenance and operation, quantity of water diverted and delivered, indebtedness of irrigation enterprises, pay roll, and employees. Inquiries made in connection with the Census of Agriculture made it possible to show the value of irrigated farms, and the tenure of the operators of these farms.

The 1940 separate Census of Irrigation was confined to 20 States, 19 of which comprise that portion of the United States in which irrigation is a recognized feature of agricultural practice; the other State, included for the first time, being Florida. The 19 States which comprised the areas covered in the 1930 and 1920 Irrigation Censuses are Arizona, Arkansas, California, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. In the remaining 28 States, irrigation is practiced to a limited, though increasing, extent to supplement uncertain rainfall. Therefore, some irrigation statistics have been obtained for these States in the 1940 and several prior Censuses of Agriculture. These data are presented in this summary together with more comprehensive 1940 figures for the State of Florida.

RELATIVE COMPLETENESS AND ACCURACY

The 1940 Census of Agriculture included questions as to the 1939 acreage of irrigated crops harvested and of irrigated pasture in all States. A duplication of inquiries relating to numbers of farms and areas irrigated was thus involved in the 1940 Farm and Ranch Schedule and the schedules used in the irrigation census. Since the larger irrigation enterprises were canvassed independently, complete harmony between the results of the two enumerations could not be expected. Although the questions on the Irrigation Schedules calling for number of farms were accompanied with the Census definition of a farm, quoted later, and specific instructions were given to base answers on that definition, it is apparent that many enterprises were unable to furnish the exact number of farms conforming to the Census definition. Instead, they gave the numbers of ownerships on their assessment rolls, or estimates,

which in some cases may have included small plots, town lots, or other irrigated units not properly considered as farms under the definition. The units reported on the Irrigation Schedules were shown as "Irrigated farms" in the 1940 Census of Irrigation State bulletins; however, that designation has been changed to "Irrigated units" in the summary tables to more clearly define the statistics and impress upon the users of the data that the figures presented may or may not represent actual farms in the meaning of that term as defined for the 1940 Census of Agriculture.

In some instances where large irrigation enterprises were known by the enumerators to have reported their irrigation operations on the Irrigation Schedules, they failed to answer the irrigated-acreage and irrigated-crop questions on the Farm and Ranch Schedules. When filling out the Farm and Ranch Schedule, some enumerators indicated irrigation by individual or other small systems, but failed to obtain Irrigation Schedules. Efforts were made to obtain missing data by correspondence or other means but not always with success.

The irrigation questions on the Farm and Ranch Schedule asked for acreages of irrigated cropland harvested and irrigated pasture, while the question on the Irrigation Schedules asked for the total irrigated area broken down into irrigated cropland harvested, irrigated pasture, and irrigated area upon which crops failed. In numerous cases the total irrigated land reported on the Irrigation Schedules included irrigated land fallowed in preparation for fall planting, land in young alfalfa, and land irrigated for erosion control, from all of which no crops were harvested, failed, or were used for pasture. These lands were not to be included in the answers to the irrigation questions on the Farm and Ranch Schedule; however, they were retained in the irrigation census statistics to show a more nearly complete use of land and water.

Farms or units and areas.—As with previous census figures, it is apparent that while the owners of the small individual and partnership irrigation enterprises were likely to have accurate knowledge of the areas irrigated in 1939 because they were also the users of the water, the officials of many large enterprises were not so likely to know the exact areas irrigated since their records show, generally, only the areas for which the water users were entitled to receive or did receive water, and not what was done with the water delivered. In the larger enterprises farmers usually obtain rights to water for their entire farms, but it was by no means universally the case that a farmer actually applied the allotted quantity to his whole farm, even though he was assessed and paid for water on that basis. Again, some enterprises, where water was not appurtenant to the lands served, kept records only of the quantity of water delivered to users and had no means of knowing the exact number of farms or acreages irrigated; therefore, the reports of these enterprises were approximations which may not always harmonize with the Farm Census reports. However, increasing numbers of the larger enterprises conduct annual crop surveys, which has tended to make their statements of areas irrigated in 1939 more accurate than those made in previous censuses.

In irrigation census enumerations, several types of duplication have to be guarded against. Many farms receive water from more than one enterprise and may be included in the areas reported by all the enterprises from which they receive water; some enterprises extend across county lines and may be reported completely more than once; and some enterprises may be known by more than one name and may be reported under each. Many differences appearing in the comparison of 1940 and 1930 statistics reflect a corrected distribution of the statistics of 1940 for extensive interstate, interdrainage basin, and inter-county projects.

The likelihood of omissions was indicated by the occasional absence of Irrigation Schedules for Farm and Ranch Schedules reporting irrigation. The two sets of schedules were carefully compared, and when irrigation reports appeared to be missing they were requested. Replies in some cases showed service by extensive enterprises for which reports had been received, and many farmers returned schedules describing small systems not previously reported. Of those who did not reply at all, it is impossible to estimate the proportion who operated

unreported systems. Relative to the total, however, the unreported enterprises did not involve large numbers, acreages, works, or investments.

The irrigable area in enterprises is probably greater, in many cases, than the area to which the reporting enterprises will ultimately be able to supply water. However, since 1920, many of the larger enterprises, especially those which have undergone financial reorganization, have carefully surveyed and scrutinized their lands, in order to ascertain the practical extent of their irrigability, considering topography, quality of soils, and quantity of water normally available or expected to be made available.

The figures for the area enterprises were capable of supplying with water in 1940 are based on the extent and condition of the physical works as they existed on December 31, 1939.

Investment in irrigation enterprises.—The amounts reported for the individual and partnership enterprises are largely estimates. The greater part of the works of such enterprises was built by the owners or their predecessors who kept no records of money or time expended. This is true also of many of the cooperative enterprises. A substantial proportion of these systems was built decades ago. Many have changed ownership within recent years, some repeatedly, with greatly changed capitalization and indebtedness resulting. Thus, investment of present owners may correctly be reported as more or less than the investment of the original or previously reporting owners.

In the 1940 census of interstate, interdrainage basin, or intercounty irrigation enterprises, the investment, indebtedness, assessments, and other charges were allocated to the various subdivisions, in proportion to the lands in each for which the works were capable of supplying water in 1940. However, the items of physical works were tabulated in the county or other subdivision in which they existed. In some instances this procedure distorted the comparisons of 1940 statistics with those of previous censuses.

Amount expended for water rights.—The question on the schedule sought any actual purchase price of water rights and also filing fees, legal fees, and court costs, but the statistics obtained, although carefully edited and checked by correspondence, can only be considered approximations of actual water-right expenditures.

Cost of maintenance and operation.—For many enterprises this cost was not reported, and no attempts were made to estimate it. It is probable, therefore, that the cost reported is based on records or on good memory and is substantially correct. In tables showing this item the irrigated areas reporting are also shown, in order to provide a gauge of the value of the averages.

Quantity of water used.—Reports on this item were obtained from the more extensive projects and from all but a few of the pumping enterprises. No figures were supplied for enterprises if the question was not answered. The data for enterprises reporting estimates and those reporting measurements are shown separately. In every case the irrigated area reporting is given to indicate the value of the averages.

Area for which drains have been installed.—The figures shown for this item are probably more accurate than those for the additional areas in need of drainage, the latter necessarily being largely estimates based on the opinion of the persons supplying the information.

Irrigation works and equipment.—The reported inventory of physical works sometimes indicated a lack of exact knowledge regarding the lengths and capacities of canals, the sizes and lengths of pipe lines, and the capacities of small reservoirs, pumps, prime movers, and wells. In some cases farm ditches may have been included and in other cases community laterals excluded, contrary to instructions. A complete inventory of quantities was not obtained for all farm pipe lines located in the large enterprises; however, the pipes reported were well grouped according to materials and types. Some confusion appeared in the designations of certain kinds of pumps, especially, in the 1940 irrigation census, between centrifugal and turbine types, and in the 1930 census, between centrifugals and rotaries. Owners of pumps and engines are presumed to know the capacities at which the pumps and engines were rated

by their manufacturers, but these ratings often vary widely and usually exceed the discharges produced in actual use. Most wells have never been tested beyond the capacities of the pumps used in them, and it is probable that in only a minority of cases have the most economic yields been determined. Therefore, in most instances the reported yields of pumped wells represent the owners' estimates of what has been pumped, based on the rated capacities of the pumps used, and not on the amounts of water which the wells could produce economically as determined by tests or measurements. Similarly, the exact lifts, including drawdown, for many pumping plants have not been ascertained accurately by farmers, although in most sections where pumping from wells is widespread, close approximations to correct figures are increasingly obtainable. Many farm tractors, pumping irrigation water, reported power much in excess of that necessary for the work performed. When such cases were revealed the horsepower was adjusted to correspond to a reasonable efficiency representative of that obtained from stationary types of internal-combustion engines, and the investment in such farm tractors was deleted from the irrigation investment. The 1940 census made inquiry as to the number of hours pumping plants were operated in 1939. This time-factor was used with the reported capacity of the pump to obtain more accurately the amounts of water pumped and applied to the land.

Finances, pay roll, and employees.—The 1940 Census of Irrigation inquired as to the "Amount expended for construction, etc. (capital expenditures), in 1939," the "Total amount of wages and salaries paid and payable for 1939," and the "Total number employed during the week ending April 29, 1939," of irrigation enterprises serving 5 or more farms. Statistics obtained from these inquiries are shown by type of enterprise and size of enterprise, and in various detailed tabulations.

Employment during the period of one week was requested in order to eliminate the effect of turn-over—so that the number of employees can be taken to correspond to the number of jobs in that period. The last week in April 1939 was selected to harmonize with the period covered by inquiries of the Bureau of the Census, on State and local governmental employment. This was desirable because many irrigation enterprises are themselves governmental units.

Wages and salaries paid and payable were requested for the year 1939 because pay-roll figures are not distorted by turn-over of personnel. The annual total thus provides a reliable indication of the volume of employment throughout the year, including both year-round and seasonal work.

The amount of wages shown should not be divided by the total number employed to arrive at average earnings per employee during the year, because turn-over and seasonal variations in employment would result in a much larger number being employed during the year than during any one week in the year.

DEFINITION OF TERMS AND EXPLANATION OF TABLES

Irrigation Census statistics are presented for 20 States, according to source of water supply, type of irrigation enterprise, type of equipment, and size of enterprise. Similar statistics are given in more detail for drainage basins and counties in each State, and in a summary, for drainage basins and individual States. The summary includes the 17 western States and Arkansas and Louisiana. In the summary, data are shown for Florida only in tables 20 and 21 (section C).

Farms.—A "farm," irrigated or nonirrigated as considered in tabulations referring to "all farms," was defined on the 1940 Farm and Ranch Schedule as:

***all the land on which some agricultural operations are performed by one person, either by his own labor alone or with the assistance of members of his household, or hired employees. The land operated by a partnership is likewise considered a farm. A 'farm' may consist of a single tract of land, or a number of separate tracts, and the several tracts may be held under different tenures, as when one tract is owned by the farmer and another tract is rented by him. When a landowner has one or more tenants, renters, croppers, or managers, the land operated by each is considered a farm. Thus, on a plantation the land operated by each cropper, renter, or tenant

should be reported as a separate farm, and the land operated by the owner or manager by means of wage hands should likewise be reported as a separate farm.

The enumerators were instructed not to report as a farm any tract of land of less than 3 acres, unless its agricultural products in the year preceding the enumeration were valued at \$250 or more. (See also discussion under "Relative Completeness and Accuracy.")

"Irrigated farms" are those reporting irrigation in the year preceding the date of enumeration. "Wholly irrigated" farms are those reporting the irrigation of all cropland harvested. "Partly irrigated" farms are all other farms reporting irrigation, including those farms on which the irrigation was confined to pasture.

Land in all farms.—The acreage designated as "Land in all farms" includes considerable areas of land not actually under cultivation and some not even used for pasture, since each farmer was asked to report as a unit all the land under his control, or rather all the land which he thought of as a part of his farm. Isolated tracts of timberland and other areas not connected with the farm were not included.

Land in irrigated farms.—This is the area of those farms which were wholly or partly irrigated in the year preceding the enumeration.

Farm values.—The operator of the farm was asked to report, first, the total value of his farm (land and buildings), including all the land which he operated, both owned and hired, whether operated for himself or managed for others. He was asked to give the current market value—that is, the amount for which the farm would sell under normal conditions, not at forced sale. The tabulated results of this inquiry are shown as "Value of land and buildings" and represents the total value of farm real estate. The values of irrigated farms are thus the values of farms which were wholly or partly irrigated.

The value of farm implements and machinery shown is that reported on the Farm and Ranch Schedule. Enumerators were instructed to exclude the value of commercial mills and factories and "permanently installed irrigation and drainage equipment."

Tenure of farm operator.—A "farm operator," according to the Census definition, is a person who operates a farm, either performing the labor himself or directly supervising it.

Owners, as used in the term "Owners and managers", include part owners as well as full owners, as classified in the Census of Agriculture.

Irrigated land.—The following instruction was given to enumerators in 1940, 1930, and 1920:

Land should be classed as irrigated which has water supplied to it for agricultural purposes by artificial means or by seepage from canals, reservoirs, or irrigated lands, but land which has natural ground water sufficiently near the surface to support plant life should not be classed as irrigated. Land which is flooded during high-water periods should be classed as irrigated if water is caused to flow over it by dams, canals, or other works, but should not be classed as irrigated if the overflow is due to natural causes alone.

"Area irrigated" is, therefore, the acreage to which water was actually applied in the seasons (1939, 1929, and 1919) preceding the enumeration years of the sixteenth, fifteenth, and the fourteenth censuses, respectively. It is not necessarily the area for which water was available or the area entitled to water; hence it does not include land under canals and sometimes irrigated but which was not watered in 1939, 1929, or 1919. Moreover, it takes no account of the degree of sufficiency of the irrigation.

Area works were capable of supplying with water.—This item relates to the year of the census (1940, 1930, or 1920). It is based on reports made by those controlling the enterprises, and represents the area which the constructed works, as they existed on January 1 of the census year, could serve, regardless of whether or not the land was farmed.

Irrigable area in enterprises (1940 and 1930) and total area in enterprises (1920).—These items represent the extent of the plans of those controlling the enterprises. Possible extensions of projects not definitely planned in 1940 or 1930 were not included in the area reported as irrigable.

Irrigated areas (1939, 1929, and 1919), irrigable areas (1940 and 1930), and areas works were capable of supplying (1940, 1930, and 1920) are net; i.e., they do not include known duplications representing areas served or susceptible of being served by more than one primary enterprise. Acreages shown for supplemental enterprises (1940 Census) constitute the portions of the areas shown for primary enterprises that received or could receive additional water.

Irrigation enterprise.—An "enterprise" is an independent irrigation establishment owning or operating works for supplying water to agricultural land. An enterprise may represent a short canal or a pumping plant watering a single small farm, or a great system of canals and reservoirs operated under one management supplying thousands of farms. Only such enterprises as supplied water for irrigation in 1939 and 1929, or were capable of supplying water for irrigation in 1940 and 1930, or were in advanced stages of construction January 1, 1940 or 1930, were included in the sixteenth and fifteenth censuses. The 1940 totals take into account various consolidations made since 1930.

Presentation of the statistics by States, drainage basins, and counties, requires that for an enterprise comprising land in more than one State, basin, or county, the part in each be considered a separate enterprise. However, the actual number of enterprises, eliminating such duplications, is shown in summary tables showing areas and investment by character of enterprise.

Type of enterprise.—The types of enterprises under which all data are classified are as follows:

Individual and partnership enterprises belong to individual farmers or to neighboring farmers who control them without formal organization. These are largely enterprises using small gravity diversions from streams, springs, or water from pumped wells.

Cooperative or mutual enterprises are controlled by the water users, under some form of cooperation, either incorporated or unincorporated. The most common form of organization is the stock company, in some sections known as the mutual water company; the shares of stock are owned by the water users and represent proportionate amounts of the available water. The stock may or may not be appurtenant to the land irrigated.

In the Southwest, where irrigation was practiced before the region became a part of the United States, part of the land is still watered by "community ditches," or public "acequias," organized and operated in accordance with old Mexican customs providing for the election of officials by the landowners and for forced labor on repairs and cleaning. These enterprises are classed as cooperative. Included also in the cooperative classification are a number of "lateral" companies, the chief function of which is to handle the distribution of water to their members beyond the places where the responsibility of their parent enterprises terminates; various storage companies controlled on a cooperative basis by groups of other enterprises; and a few mutual companies, especially in southern California, which expect eventually to supply their members with water for domestic purposes only, but meanwhile use their surplus supplies for irrigation.

Not included in the tabulations were various water-user organizations, essentially cooperative, which have administrative, managerial, protective, or sometimes promotional functions but own and operate no physical works although perhaps assessing their members for various costs and expenses. (See, also, United States Bureau of Reclamation enterprises.) Usually such omitted enterprises operated within the year to safeguard the existing or prospective rights of their members but did not own or distribute water.

Irrigation districts are public corporations established under State laws empowering them to issue bonds to obtain funds for the purchase or construction of irrigation works and to levy and collect taxes or assessments for the payment of bonds and interest on them, and the cost of maintenance and operation of the works. The term "irrigation districts" also covers water-improvement districts, water-conservation districts, and water-storage districts, which in some States are in addition to irrigation districts and in other States are in lieu of them.

Irrigation districts are controlled by the owners of the lands comprising them through boards of directors elected by the landowners. A few districts which have the sole function of storing water for other enterprises are included in the classification. (See, also, United States Bureau of Reclamation enterprises.)

Commercial enterprises, incorporated or otherwise, supply water for compensation to farmers who own no interest in the works. Such enterprises may be organized in any form, but their operations are subject to some degree of public control in most States. This was the earliest type of enterprise for the construction of large irrigation systems. Such enterprises built irrigation works and sold rights entitling the purchasers to receive water carried by them upon the payment of annual charges, but conveyed no interest in the works. Some States have enacted laws prohibiting the sale of such rights, and commercial enterprises organized since the passage of these laws usually sell stock representing part ownership in the works, to become effective upon the payment of specified portions of the purchase

price. These enterprises eventually become cooperative. There are some commercial enterprises that sell no rights but supply water to the public upon payment of charges based, in some instances, on acreage served and in other instances on the quantity of water delivered. In most States rates charged by commercial enterprises are subject to public control; they are, therefore, considered public utilities.

United States Office of Indian Affairs enterprises operate under various Acts of Congress providing for the construction of works for the irrigation of land in Indian reservations.

United States Bureau of Reclamation enterprises were established in the Department of the Interior under the Federal law of June 17, 1902, which provided for the construction of irrigation works with the receipts from the sale of public lands or other sources, and subsequent legislation which provided other funds. In addition to serving land within its own projects, the Bureau of Reclamation supplies supplemental water to land within other enterprises. Statistics relating to "primary" acreages classified as "United States Bureau of Reclamation" do not include acreages served with supplemental water, since the latter areas are represented in other classifications, but the construction costs of facilities under contract to provide such supplemental water are included in the investment credited to the Bureau of Reclamation. Drainage construction costs, which are an integral part of the cost of most Bureau of Reclamation projects, are excluded from the investment credited to the Bureau of Reclamation. In many instances construction costs which will be repaid by power revenues from works operated in conjunction with Bureau of Reclamation enterprises are included in the investment so credited, as specifically noted in the appropriate tables. Statistics apply only to Bureau of Reclamation enterprises in operation and not to projects under construction which are not yet irrigating land.

Amendments to the Reclamation Act provide that on the request of any water-user organization or irrigation district the Secretary of the Interior, at his discretion, may transfer to such local organization the operation and maintenance of all or any part of the project works. Under this provision the operation and maintenance of 41 projects or divisions of projects have been turned over to water-user organizations or irrigation districts. As the construction cost of no project has been paid in full, title to the works remains with the Federal Government and all projects in this status are classified as Bureau of Reclamation enterprises.

State enterprises are undertakings by the States themselves to effect irrigation development under special legislation. Some projects originally in this status have been reorganized and their statistics appear in other classifications. Also, "State" enterprises include various State institutions having independent irrigation systems serving their own lands exclusively.

City water and city sewage-disposal enterprises include those established by a few cities to dispose of sewage by utilizing the effluent for irrigation. Others, notably in Utah and California, maintain substantial irrigation service in conjunction with their domestic and industrial deliveries on an irrigation rate schedule. Statistics for both such types of enterprise are classified as "city."

Other enterprises include several projects still operated by companies established under the Federal law of August 18, 1894 (usually referred to as the Carey Act), granting each of the States in the arid region 1,000,000 acres of land on condition that the State provide for its irrigation, and under amendments to that law granting additional areas to several of these States, if applied for. The conditions in this law necessitate State legislation before the law becomes operative; thus Carey Act enterprises operate under both Federal and State laws. Practically all enterprises which were originally Carey Act projects have been reorganized and were enumerated as cooperatives or other types in the 1940 Irrigation Census. Also among the enterprises classified as "Other" are a few "drainage" districts which operate irrigation as well as drainage systems, and a number of "reclamation" districts (largely in California). Most of the reclamation districts have flood control or drainage as their principal function, irrigation being of varying importance but subordinate to flood control. Reclamation districts have no connection with United States Bureau of Reclamation enterprises.

Data were obtained from various Government agencies not referred to above which use water on areas devoted to refuges for wild life. Since these enterprises appeared to be outside the scope of both the Census of Agriculture and the Census of Irrigation the data reported were not retained. Forest nurseries operated by the United States Department of Agriculture were likewise omitted.

Multiple-purpose enterprises.—The number of multiple-purpose enterprises which render irrigation service in connection with other services has increased during recent years. In the 1940 census, cities and public utility enterprises which supply irrigation water from domestic water systems or extensions thereof and/or from the effluent of sewage disposal plants, were recorded as irrigation enterprises, provided the revenues received from irrigation were segregated from other receipts and represented substantial amounts. Cities supplying water to only a few irrigators at domestic water rates were not considered irrigation enterprises; however, each farmer receiving such water was counted as an individual enterprise with a "City water" supply. Large multiple-purpose enterprises involving water storage, power development, flood protection, channel betterment, ground water recharge, and other

functions in addition to irrigation, were enumerated as irrigation enterprises. In each case, however, unless otherwise indicated, only such construction statistics were included in the 1940 Irrigation Census tabulations as could reasonably be allocated to the irrigation phase or purpose. Thus, the allotment was determined from varying factors such as capital chargeable to the irrigated land, works used wholly for irrigation, actual or anticipated irrigation revenues, etc. Drainage, reclamation, irrigation, and other types of districts which in 1939 rendered an irrigation service with one or more additional services were classed as irrigation enterprises and the works and costs in each case were allocated as closely as possible to each purpose. For instance, in the case of enterprises operating pumping plants primarily installed for drainage purposes but using the pumped water for irrigation, the capital costs were allocated to drainage and the cost of maintenance and operation to irrigation.

Primary and supplemental enterprises.—Each irrigation enterprise, regardless of type, was classified in the 1940 Census as "primary," "supplemental," or a combination of both, according to the water service it rendered to irrigators.

A primary enterprise is one which furnishes to the irrigators all, or the major portion, of the irrigation water used. A stream diversion or pumping plant which one or more farmers consider a principal source of water and which is used first in preference to other available sources because of ownership of works or water rights, or lower costs of water, is a typical primary enterprise regardless of the proportion of water obtained from such other available sources. All irrigated land must receive water from one primary enterprise, and the area statistics for primary enterprises are totals.

A supplemental enterprise is one which, directly or indirectly, furnishes a user with water from a source either like or different from the primary source, in addition to the water he receives from a primary enterprise. Notable supplemental enterprises are upstream or offstream storage projects established for the conservation of winter run-off and floodwater and to augment the insufficient primary supplies of downstream users. Likewise, many supplemental pumping plants have been installed either by individuals or groups for lifting ground water or water from streams to provide for areas served inadequately from primary sources alone.

Drainage basins.—The drainage basin of a stream is the geographic area drained by that stream and its tributaries. Large river systems drain major basins, each of which for the purpose of the Irrigation Census has been divided into tributary or minor drainage basins. Each basin, major or minor, is usually designated by the name of its arterial stream. Waters from most major basins ultimately reach the sea through surface or underground channels. However, the areas of the "Great Basin" comprising portions of Wyoming, Utah, Nevada, Oregon, and California, and similar smaller areas in other western States, drain into landlocked lakes or sinks and are considered as closed or independent basins. The drainage basin tables for a State set forth the portions of the major basins and their principal tributaries or minor basins located within the State, while the summary tables for the 17 western States and Arkansas and Louisiana set forth totals for all interstate basins and for groups of intrastate basins. Because a drainage basin is the natural geographic planning unit for the efficient utilization and administration of waters of the drainage basin streams and the included lands, irrigation statistics are shown in detail for drainage basins similar to those shown for States and counties.

Twenty State maps and a key map of the western portion of the United States, with Florida inserted, are published separately to show the boundaries of the specific drainage basins enumerated in the 1940 Census of Irrigation with symbols which represent the acreages irrigated in 1939. These maps, "Irrigation—By Drainage Basins—1939", may be purchased for 15 cents each, except for California and Texas which are printed in two sections and each section is 15 cents, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Areas irrigated from springs, flowing wells, or pumped ground waters are credited to the drainage basin in which they are located.

In the 1940 Census, irrigation from or along a tributary stream, not mapped in an individual basin, was considered a part of the irrigation "Direct" from the arterial stream into which the tributary flows. In the Irrigation Censuses of 1902,

1920, and 1930, when irrigation statistics were also tabulated by drainage basins, the boundary lines of the basins were not mapped and although data were shown for the arterial streams "Direct" and for tributary basins in a manner similar to that used in the 1940 Irrigation Census, many minor basins were grouped under "Other tributaries," a grouping not used or carried forward in the 1940 Irrigation Census Reports. Since it was not always possible to identify and separate the statistics of basins included in "Other tributaries," some tributaries so included in this item in prior censuses may be included under "Direct" in 1940. Therefore, the data presented under "Direct" for these earlier censuses should be considered as only approximately comparable to those shown for 1940. Also, wherever comparable data are not shown in the 1940 drainage basin tables, it is reasonable to assume that the statistics for the basins involved were probably included in "Other tributaries" in the reports of prior censuses.

Sources of water supply.—The water supplies named in the tabulations are self-explanatory with the possible exception of "Stored storm water," which refers to storm water collected from channels that carry water only during storms and are not classed as streams, or by run-off from local lands usually owned or controlled by the irrigators and stored in small reservoirs. Storm water reservoirs are usually owned by individual farmers and have recently been increased in number to provide irrigation and stock water, or to retard surface waters until they percolate into underground storage from which irrigation water is pumped.

In the 1940 Census, the classification of sources of water supplies was expanded somewhat to group those enterprises which have like combinations of primary sources and those which receive supplemental water from streams by gravity, from storage, or by pumping. Where these supplemental sources appear, no comparison can be made with the statistics of previous Censuses. All areas shown as receiving water from supplemental sources are also included in the areas shown as receiving water from primary sources; however, duplication of area statistics is avoided in the tables showing sources of supply by omitting from the totals land served from supplemental sources. The amounts of water delivered, and investment and cost statistics are shown separately for each source classification.

Water rights.—The 1940 irrigation census made inquiry regarding the type of water rights held by the reporting enterprise with three questions calling for indication of "Riparian," "Appropriation," and "All other" rights, with instruction accompanying the questions directing that rights other than riparian or appropriative be reported under "All other," and that definite designation of the "Other" type be made. More specific questions or instructions might have resulted in the reporting of a greater number of "Other" types, as in many instances the enterprises failed to identify such other rights. The water-right tabulations present acreage figures according to the predominating types of rights reported, but owing to the lack of knowledge of the distinctions between the various types on the part of many irrigators and enumerators, the tabulations can only be considered to disclose approximately the actual situation.

For the sake of such comparisons as may be significant, the water-right tabulations of the 1930 Irrigation Census are shown. However, present interest in water-right statistics appears to lie principally in the relative status of appropriative to riparian rights in States which recognize both, and in rights to ground water, rather than to the various stages in which appropriative rights exist.

Cost of irrigation works and equipment.—The census instruction was as follows:

Include the original cost of the irrigation works plus the cost of extensions and improvements; also the cost of equipment, buildings, and land used for maintenance and operation, but not water rights. If works are not completed, give investment to December 31, 1939. If there are no records of cost, or if the owners have done all or part of the construction, the best estimate of cost obtainable should be reported, including the estimated value of the work done by the owners. Only such costs for drainage works as are chargeable to irrigation should be included.

Cost of water rights.—Instructions specified that this item should "include filing and legal fees paid by the enterprise in acquiring them; and, if they were purchased by the enterprise, give the purchase price."

The 1940 Census tabulations show the reported cost of water rights separately, while in previous censuses this item was added to the cost of irrigation works and presented as "capital investment." However, the cost of irrigation works and equipment and the cost of water rights were added together in 1940, as in previous censuses, to produce figures representing total investments and these totals were related to acreages the works were capable of supplying with water in 1940, as previously, to produce comparable average investments per acre.

Financing.—The 1940 Irrigation Census made inquiry for the first time regarding the financial status of those enterprises designed to serve 5 or more farms. The total indebtedness and the arrears in payment of principal or interest on bonds or other funded obligations, were reported as of December 31, 1939. Inquiry was also made as to the amount of arrearage, December 31, 1938, the amount of water taxes, including special assessments, and the amount expended for construction in 1939, as capital expenditure. In the tabulations shown the financing items have been related to the areas, capital investment, and charges and assessments of enterprises reporting indebtedness, as far as the replies permit.

Cost of maintenance and operation.—Instructions were to "report only the costs of maintenance, including ordinary cleaning and repairs, and operations, including fuel, electric energy, and attendance." Also to be included were the amounts of operating and maintenance costs of the drainage pumps or systems which are chargeable to irrigation. In tables showing these costs, they are related to the acreages irrigated in 1939 by the enterprises reporting.

Main canals and laterals.—A main canal is any open conduit conveying water from the source of supply to the tract of land to be irrigated or to a storage reservoir. A lateral canal is a branch of a main canal conveying water from a main canal to one or more farms. Main canals and laterals are tabulated as "canals." Farm ditches which distribute water to fields within the boundaries of the individual farm are not reported. Lengths of earth canals and lined canals, including flumes, appear separately in the tabulations. The material used, for most lined canals, was reported as concrete.

Diversion dams.—A diversion dam is a structure placed across the channel of a natural stream for the purpose of diverting all or a portion of the stream flow into a canal or other water conduit. Many of the diversion dams reported are temporary structures built of sand, rock, brush, or other accessible materials. Tables classifying diversion dams by material include these temporary structures as "other and mixed" because of the variety of materials used. Most such dams are destroyed during periods of high water and have to be replaced annually or even more frequently.

Storage dams and reservoirs.—A storage dam is a structure built for the purpose of storing water in a stream channel, ravine, or other natural depression. These dams are tabulated according to the materials of construction. Dams were not reported for all reservoirs as many small reservoirs are built by excavation and embankments on level ground in connection with pumping plants for overnight storage. Tanks and other small structures capable of storing less than 1/2 acre-foot of water were not included in the tabulations.

Pumping plants.—The census of pumping plants was confined to those used for lifting irrigation water and were enumerated and tabulated according to the kind of motive power, i.e., "electric motors," "internal-combustion engines," and "other power"; and by type of pump, i.e., "centrifugal," "turbine," "plunger," and "other pumps." Steam, water, and wind were classed in "other power." Rotary, hydraulic ram, air lift, and home-made pumps were classed as "other pumps." The inquiry regarding the average lift of pumping plants called for the vertical distance, in feet, between the average elevation of the water in the source of supply when the pump is running at usual capacity and the average elevation to which the water is lifted. It does not take into account friction and velocity heads. The lift statistics show separately the lifts from wells and from surface sources to indicate the lifts of ground water in areas irrigated from wells.

Units of measure.—The following units of measure are used in this report:

Capacity of a canal at main heading is given in second-feet ("sec.-ft." or "c.f.s."), abbreviations for "cubic feet

per second." A second-foot is the rate of discharge of water flowing in a channel when the cross-sectional area is 1 square foot and the average velocity is 1 foot per second.

Capacity of a pump and yield of a well is given in gallons per minute ("g.p.m."). Approximately 450 g.p.m. equals 1 sec.-ft.

Capacity of a reservoir is given in acre-feet ("ac.-ft."). An acre-foot of water is the quantity that will cover 1 acre to a depth of 1 foot, and equals approximately 43,560 cubic feet or 325,851 gallons.

Capacity of a motor and an engine is given in horsepower ("hp."). One horsepower is the energy required to lift 33,000 pounds through a vertical distance of 1 foot in 1 minute.

Irrigated crops.—Table 22 (section C) carries data for specified crops grown on irrigated and nonirrigated lands in the 17 western States and Arkansas and Louisiana in 1939, with comparable acreages for 1929, where available. The average yields shown in this table for irrigated crops are based on the farms reporting the entire crop irrigated, while the yields for nonirrigated crops are based on farms reporting no irrigation for such crops. The 1939 basic data for these crops appear in volumes I and III of the Reports for the 1940 Census of Agriculture. The 1929 basic data for the irrigated crops appear in the 1930 report "Irrigation of Agricultural Lands" and totals for all crops in volumes II and IV of the Reports for the 1930 Census of Agriculture. In the 1940 Census, a farm reporting both irrigated and nonirrigated acreages of a given crop was recorded as a farm in each group. Therefore, the total of the farms reporting irrigated and nonirrigated acreages for a crop exceed the actual number of farms harvesting that crop to the extent of the number of farms which used both irrigated and nonirrigated culture in the census year.

Farm mortgage debt and taxes on irrigated farms.—In the 1940 Census of Agriculture, mortgage and tax information was obtained only for farms of full owners and for the owned portions of farms of part owners. The mortgage inquiries called for the mortgage status (the amount of mortgage debt) and the rate of interest on the first mortgage. The tax inquiries called for taxes levied on the real estate in the farm as well as those levied on personal property on the farm. The statistics are shown separately for full owners and for part owners. In presenting the mortgage statistics, farms are classified by mortgage status and the amount of debt is related to the acreage and value of the farms reporting these items. The number of farms, acreage, and value are also shown by mortgage status.

In presenting the statistics for farm taxes, the real-estate taxes are related to the acreage and value of the farms reporting these items. A more detailed discussion of mortgage and tax statistics for all owner-operated farms are presented by States in chapter IV, of volume III, of the Reports of the 1940 Census of Agriculture. The statistics relating to mortgages and taxes presented in that volume are restricted to farms of owner operators where all of the cropland harvested in 1939 was irrigated.

In comparing the mortgage and tax statistics for irrigated farms with those for all farms it cannot be assumed that the differences in the totals represent nonirrigated farms only. Such differences include not only nonirrigated farms, but also farms where irrigation was restricted to pasture lands, fallow land, and to partly irrigated farms where only a portion of the crops harvested were irrigated.

Separate figures for mortgage debt and real-estate taxes are presented for owner operators owning no additional land. The mortgage and tax data for these farms are not distorted by any debt or taxes which might relate to other land.

The interest rate reported was the annual rate as specified in the first mortgage. Figures given for this item are presented under "Average of the rates." They do not represent weighted averages as they are simply the sum of the rates reported divided by the number of reports.

The real-estate taxes were to relate to the taxes levied in 1939 on the real estate of the farm owned by the operator on April 1, 1940, including buildings and other improvements. Taxes levied by drainage or irrigation districts were not to be included.

The personal-property taxes were to relate to taxes on personal property such as livestock, machinery, etc. owned by the operator and on the farm operated. Automobile taxes, fees, and licenses were to be excluded.

GENERAL DISCUSSION

(Section B)

GENERAL DISCUSSION

Precipitation for Census Years

The Census of 1940 completed a span of 50 years in which the Federal Census has gathered statistics on irrigation. Table 1 shows the eight individual years when irrigation enumerations were made and the mean annual precipitation and departures from normal for those years, as recorded by the United States Weather Bureau. The average monthly precipitation, by States, for the water year (October 1938 through September 1939), is given in table 2. These data, together with those for recorded rainfall and departures from normal for all years from 1888 to 1939, are presented graphically in charts I to VIII. An analysis of these figures indicates that in most States the annual precipitation was below normal in most of the census years. In many sections of the West the areas most affected by variations in the amount and distribution of precipitation are lands reported as irrigated pasture. This acreage seems to accord largely with the fluctuations in the amount of water available for pasture irrigation in the spring and

fall, before and after the requirements of other more valuable crops are satisfied, a relation and practice which should be taken into consideration in the use of irrigated pasture data. When a census year falls in, or at the end of, a drought or period of excessive precipitation, the available water supply, areas irrigated, and crop yields are correspondingly affected. Therefore, users of Census data should take into consideration, in their interpretation of irrigation Census statistics, the precipitation factor for the years concerned.

Precipitation for the calendar year 1939 and the water year (October 1938 through September 1939) was below normal in the 19 western Irrigation States. Colorado, California, and Nebraska received the least rainfall during 1939, amounting to 65, 67, and 72 percent of normal, respectively. Idaho, Kansas, eastern Oregon, eastern Washington, and Wyoming received approximately 75 percent of their normal precipitation (see tables 1 and 2). Additional tabulations and discussions of precipitation and temperatures for the years 1938 and 1939 accompany each State report following this summary.

TABLE 1.—PRECIPITATION AND DEPARTURES FROM NORMAL: 1889, 1899, 1902, 1909, 1919, 1929, 1934, AND 1939
(For the 17 western States and Arkansas, Louisiana, and Florida)

STATE	Normal for period	PRECIPITATION																	Percent of normal
		1889		1899		1902		1909		1919		1929		1934		1939			
		Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Amount	Depart. ¹	Percent of normal	
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		
Arizona	13.89	13.29	-0.60	8.61	-5.28	10.23	-3.68	14.48	+0.59	20.70	-6.81	11.29	-2.60	10.47	-3.42	12.88	-1.01	93	
Arkansas	48.25	45.61	-2.64	41.49	-6.76	51.70	+5.45	44.08	-4.20	54.52	-6.27	46.10	-2.15	42.47	-5.78	50.16	+1.91	104	
California	23.72	33.25	+9.53	22.47	-1.25	24.22	+0.50	42.15	+18.41	21.29	-2.43	15.00	-8.72	18.01	-5.71	15.80	-7.92	67	
Colorado	16.38	13.73	-2.65	14.67	-1.71	13.88	-2.50	20.98	+4.58	17.14	+0.76	18.16	+1.78	10.89	-5.49	10.68	-5.70	65	
Idaho	17.96	14.76	-3.20	18.96	+1.00	16.98	-1.00	22.83	+4.87	15.97	-1.99	13.94	-4.02	16.10	-1.86	13.73	-4.23	76	
Kansas	26.43	29.44	+3.01	26.26	-0.17	34.42	+7.99	31.15	+4.72	25.65	-0.78	27.96	+1.53	20.02	-6.41	20.08	-6.35	76	
Louisiana	55.45	41.21	-14.24	42.19	-13.26	46.89	-8.56	55.25	-2.20	69.23	-13.78	63.65	-8.20	59.23	-3.78	51.51	-3.94	93	
Montana	15.23	8.94	-6.29	15.74	+0.51	15.12	-0.11	19.72	+4.49	10.88	-4.35	13.08	-2.15	11.87	-3.36	12.85	-2.40	84	
Nebraska	22.56	22.29	-0.27	19.55	-3.01	29.47	+6.91	24.64	+2.08	25.09	+2.53	22.74	+0.18	14.31	-8.25	16.28	-6.28	72	
Nevada	9.22	12.41	+3.19	9.12	-0.10	7.25	-1.97	11.03	+1.81	7.08	-2.14	5.85	-3.39	7.12	-2.10	8.48	-0.74	92	
New Mexico	14.43	10.97	-3.46	10.98	-3.45	9.97	-4.46	12.83	-1.60	20.95	+6.52	16.48	+2.05	10.08	-4.35	13.22	-1.21	92	
North Dakota	16.87	11.54	-5.33	17.62	+0.75	19.35	+2.48	18.10	+1.23	15.59	-1.28	14.31	-2.56	9.51	-7.36	14.15	-2.72	84	
Oklahoma	32.27	31.01	-1.26	36.07	+3.80	40.54	+8.27	27.01	-5.26	34.41	+2.14	35.39	+5.12	27.46	-4.61	26.71	-5.56	85	
Oregon	26.10	29.79	+3.69	31.06	+4.96	29.88	+3.78	32.85	+6.75	26.21	+0.11	19.33	-6.77	25.87	-0.23	20.77	-5.33	80	
Eastern Division	13.81	16.60	+2.79	15.23	+1.42	12.60	-1.21	17.00	+5.19	12.41	-1.40	11.58	-2.23	14.07	+0.26	10.50	-5.51	78	
Western Division	53.83	30.38	-23.45	66.70	+12.87	68.76	+14.93	69.31	+15.48	57.28	+5.45	38.66	-15.17	53.53	-0.30	43.90	-9.93	82	
South Dakota	18.87	18.34	-0.53	18.84	-0.03	19.54	+0.67	22.74	+3.87	19.64	+0.77	20.65	+1.76	12.58	-6.29	15.71	-3.16	83	
Texas	30.63	38.06	+7.43	28.70	-1.93	33.92	+3.29	23.45	-7.18	45.64	+15.01	31.17	+0.54	26.78	-3.85	24.69	-5.94	81	
Utah	12.95	12.67	-0.28	11.85	-1.12	9.17	-3.78	19.31	+6.36	11.85	-1.12	13.60	+0.65	9.52	-3.43	11.49	-1.46	89	
Washington	34.75	31.85	-2.92	45.07	+10.32	40.24	+5.49	55.87	+1.12	31.00	-3.75	23.74	-11.01	38.27	+3.52	32.00	-2.75	92	
Eastern Division	16.70	13.62	-3.08	18.97	+2.27	17.69	+0.99	17.40	+0.70	18.22	+1.52	10.19	-6.51	17.13	+0.43	12.85	-3.87	77	
Western Division	57.33	56.02	-1.31	67.87	+10.54	62.98	+5.65	58.75	+1.42	52.08	-5.25	44.01	-13.32	69.97	+12.64	59.74	+2.41	104	
Wyoming	14.01	12.93	-1.08	13.58	-0.43	9.81	-4.20	16.33	+2.32	10.46	-3.55	15.06	+1.05	10.88	-3.13	10.27	-3.74	73	
Florida	52.73	50.89	-1.84	52.65	-0.08	51.33	-1.40	48.37	-4.36	57.50	+4.77	59.19	+6.46	52.94	+0.21	54.54	+1.61	103	

¹Departure from normal.

TABLE 2.—MONTHLY AND ANNUAL PRECIPITATION WITH ANNUAL DEPARTURE FOR CALENDAR YEARS, 1938 AND 1939; AND MONTHLY AND TOTAL PRECIPITATION WITH DEPARTURE FOR PERIOD FOR WATER YEAR, OCTOBER 1938 THROUGH SEPTEMBER 1939
(For the 17 western States, Arkansas, Louisiana, and Florida)

STATE	PRECIPITATION																	
	Water Year																	
	1938									1939								
	Jan.-Mar.	Apr.-June	July-Sept.	Oct.	Nov.	Dec.	Pre- cipi- tation	De- par- ture ¹	Jan.-Mar.	Apr.-June	July-Sept.	Oct.	Nov.	Dec.	Pre- cipi- tation	De- par- ture ¹	Annual	Annual
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Arizona	4.58	1.29	4.56	0.10	0.07	2.20	12.80	-1.09	1.12	1.20	0.68	0.56	0.04	0.04	1.16	2.36	5.79	13.30
Arkansas	18.58	12.99	7.55	0.94	5.26	2.93	48.25	0.00	6.21	8.56	3.71	7.13	4.85	4.50	3.34	2.53	1.77	51.73
California	21.31	2.59	0.60	1.61	1.17	2.78	30.06	+6.34	3.23	2.25	2.90	0.52	0.97	0.12	0.08	0.07	1.70	17.40
Colorado	3.98	6.23	6.45	0.97	0.93	0.89	19.35	+2.97	1.30	1.09	1.14	0.91	1.03	0.82	0.90	1.08	1.10	12.06
Idaho	7.02	4.40	2.19	2.58	1.91	1.46	19.56	+1.60	1.69	2.01	1.29	0.68	0.81	1.29	0.89	0.16	0.97	15.54
Kansas	5.67	14.05	7.62	0.33	1.40	0.20	27.27	+0.84	0.78	1.22	1.72	1.96	2.35	4.59	1.40	3.50	0.32	19.77
Louisiana	11.99	14.16	15.23	1.32	4.03	3.53	50.26	-5.19	5.62	5.69	2.89	2.40	6.72	4.42	5.97	4.86	3.23	50.68
Montana	2.54	6.98	3.88	1.75	0.89	0.56	16.60	-1.37	0.70	0.81	0.72	0.78	1.89	3.52	0.68	0.62	0.94	13.86
Nebraska	2.41	10.65	8.09	0.18	0.72	0.18	22.23	-0.33	0.70	0.87	1.21	1.40	2.53	3.84	1.85	2.04	0.44	15.94
Nevada	4.67	3.52	1.34	1.32	0.52	0.42	11.79	-2.57	0.96	0.78	0.95	0.79	0.73	0.19	0.60	0.34	1.34	8.94
New Mexico	2.38	3.48	6.63	1.10	0.27	0.76	14.62	+0.19	1.39	0.61	0.76	0.88	0.72	0.64	2.45	1.76	1.83	13.17
North Dakota	1.75	6.37	5.47	0.55	0.87	0.32	15.33	-1.54	0.47	0.63	0.39	0.87	1.55	4.59	1.81	2.10	0.68	14.83
Oklahoma	10.15	13.20	6.51	0.52	2.21	0.62	33.21	+0.94	2.79	1.67	1.82	2.44	3.76	5.35	1.65	2.66	0.33	25.82
Oregon	13.33	5.60	1.49	2.06	3.35	2.48	26.31	+0.21	2.90	3.53	2.23	0.44	1.07	1.05	0.49	0.35	0.64	20.59
Eastern Div.	6.70	2.87	1.30	1.29	1.71	1.02	14.89	+1.08	1.09	1.68	1.22	0.22	0.76	0.61	0.35	0.12	0.55	10.62
Western Div.	28.05	5.25	1.93	3.80	7.04	5.76	51.83	-2.00	6.97	7.70	4.51	0.93	1.75	2.03	0.79	0.88	0.88	43.02
South Dakota	2.35	8.67	5.49	0.16	0.57	0.26	17.50	-1.37	0.95	0.60	0.85	0.35	1.03	2.32	4.15	1.85	1.92	10.27
Texas	7.12	9.65	6.32	0.87	1.50	1.72	27.18	-3.45	3.10	1.86	1.04	1.47	3.16	3.05	2.60	2.21	1.12	23.70
Utah	5.24	3.60	2.52	1.70	1.16	0.97	15.19	+2.24	1.87	1.29	0.94	0.78	0.86	0.85	0.54	0.66	2.61	13.53
Washington	11.40	4.23	1.34	3.55	4.01	4.54	29.27	-5.48	5.79	4.44	2.45	0.91	1.52	1.64	0.84	0.43	0.84	30.96
Eastern Div.	6.30	2.07	0.91	1.64	1.70	1.17	13.79	-2.91	1.97	1.99	1.12	0.43	0.60	0.85	0.18	0.13	0.34	12.12
Western Div.	19.05	7.52	2.68	6.40	7.48	9.59	52.70	-4.83	11.51	8.12	4.45	1.64	2.90	2.83	1.84	0.87	1.59	59.20
Wyoming	2.61	5.75	4.04	1.17	1.01	0.88	15.26	+1.25	0.78	0.85	0.68	0.96	1.57	1.70	0.81	0.78	0.92	11.91
Florida	5.28	12.14	18.10	4.70	1.60	1.35	43.17	-9.56	1.62	2.25	1.54	4.32	5.01	9.13	7.59	10.78	5.79	55.68

¹Departure from normal.

Areas Irrigated

The total area irrigated in 1939 in the 17 western States and Arkansas and Louisiana, reported by the Census of Irrigation (table 3), was 21,003,739 acres, an increase of 1,456,195 acres, or 7.4 percent since 1929. This is a greater rate of increase than the 1.9 percent increase during the preceding decade, yet much less than that for the decade 1909-1919 when an increase of 33.0 percent was shown. In the 1929-1939 period, increases were shown in 15 States, and decreases were recorded for Colorado of 5.1 percent, Louisiana of 0.8 percent, South Dakota of 10.3 percent, and Utah of 11.2 percent. The 1939 irrigated areas by principal drainage basins show increases in all basins, with the exception of the Rio Grande which shows a decrease of 2.8 percent, since 1929.

The distribution of 1939 irrigated areas by type of irrigation enterprise (table 4) shows increases for all types with the exception of "Commercial," -17.3 percent; and "All other," -2.4 percent. The transferring, during the past decade, of "Commercial" and "All other" (miscellaneous) types of enterprises into water-user organizations such as "Cooperatives," "Irrigation districts," and "Government projects" probably accounts for most of these area changes by type of organization. The greatest decade increases of area irrigated, by type of enterprise, were reported by Individual and partnership, 903,571 acres, Cooperatives, 381,154 acres, and Bureau of Reclamation, 338,976.

Charts IX and X show graphically the historic trends of areas by type of enterprise related to investment. For the Census of 1940, the areas and investment involved in developments for supplemental water are graphically presented with the supplemental investment shown in a side column; this is also added to the top of the primary investment column. Investment columns for earlier census years represent total expenditures for primary and supplemental projects unsegregated. Therefore, the total investment column (primary plus supplemental) in 1940 is comparable with the investment columns of previous years. Likewise, the average investment per acre is based on totals for all years except 1940 when separate averages for primary and supplemental enterprises are shown. In the graph for "All Types" an average based on totals for 1940 is also shown because the total investment applies to the total primary acreage. In the graphs for the individual type of enterprise an average investment per acre based on total investment is not shown because the supplemental investment usually applies to areas administered under one or more types other than the one credited with the investment.

Areas irrigated in 1939 in the 29 humid States (exclusive of Arkansas and Louisiana) are shown in table 5. These States are arranged in order of number of farms irrigated in 1939. All historic irrigation statistics (obtained by the Bureau of the Census) for the period of 1899 to 1939, inclusive, are shown. It is noted that the area irrigated in Florida in 1939 exceeded the area irrigated in the individual semihumid States of Oklahoma, North Dakota, South Dakota, or Kansas; and, also, the irrigated area in New Jersey, New York, or Ohio was greater than that irrigated in Oklahoma.

Capital Invested

The total investment of \$1,052,049,201 in irrigation works and water rights reported by enterprises in the 1940 Irrigation Census for the 17 western States and Arkansas and Louisiana (table 3) continued the upward trend from \$892,755,790 in

1930 an increase of \$159,293,411, or 17.8 percent. The change in investment per acre, based on the area irrigation works were capable of supplying with water, was from \$34.20 in 1930 to \$37.50 in 1940, indicating that the costs of additional irrigation works and betterments per unit irrigated also continued to increase, as has been true from the beginning of Census Records. Likewise, the estimated cost to complete the irrigation works in existing enterprises based on the irrigable lands in these projects changed from \$33.17 per acre in 1930, to \$35.99 per acre in 1940, an increase of \$2.82 per irrigable acre in the projects. Charts IX and X show graphically the historic trends of capital invested, related to project areas.

California ranks first in the 19 Irrigation States in capital invested in irrigation enterprises with \$318,889,218, or 30.3 percent of the total, the decade increase being 2.5 percent; Colorado second with \$106,849,343, or 10.2 percent of the total, with a decade increase of 22.0 percent; and Idaho third with \$102,585,798, or 9.8 percent of the total, a decade increase of 21.4 percent. Investment increases for the decade were reported in each of the 17 western States. However, the States of Arkansas and Louisiana, where irrigation is principally pumping water for rice, showed capital decreases of 15.6 percent and 26.5 percent, respectively, although the irrigated areas increased in Arkansas 6.5 percent and the number of irrigation enterprises increased in both States. Some of the factors causing these decreases are revealed by the statistics showing losses and gains in capital invested by counties and parishes in Arkansas and Louisiana, respectively, which indicate considerable shifts of location of irrigation practice within these States since 1930. Such shifts require the abandonment of old wells and pumping plants, many of which were installed prior to 1920 at high costs, and the installation of new wells and/or pumping equipment. Irrigation statistics of the Census of 1940 compared with 1930 also indicate a change from steam and internal-combustion engines to more efficient electric motors at less cost per horsepower. There are indications that new engines and wells installed during the decade 1930-40 cost less than those they have replaced which were of the earlier installations.

The Columbia River Drainage Basin ranks first in the 12 principal drainage basins in capital invested in irrigation enterprises (\$206,523,302 or 19.6 percent of the total) and also reported the greatest decade increase (\$49,168,188 or 31.2 percent). The Missouri River Drainage Basin ranks second (\$179,750,238 invested or 17.1 percent of the total, with a decade increase of \$43,243,517 or 31.7 percent), and the Sacramento-San Joaquin Delta and tributaries third (\$171,004,939 or 16.2 percent of the total, with a decade increase of \$6,376,846 or 3.9 percent).

Irrigation districts continue to lead in total investment by type of organization with \$265,737,810, or 25.3 percent of the total, an increase within the decade of 26.1 percent (charts IX and X). The United States Bureau of Reclamation ranks second with \$250,245,359, or 23.8 percent of the total, a decade increase of 29.0 percent; and cooperatives rank third with \$224,140,876, or 21.3 percent of the total, a decade increase of 25.0 percent. State enterprises (summary table 7, section C) lead in percentage increase of investment with 57.7 percent; the United States Office of Indian Affairs second, 53.3 percent; and the United States Bureau of Reclamation third, 29.0 percent. Decreases in investment are shown by City and/or sewage enterprises, with 63.7 percent, and Individual and partnership, 0.3 percent.

Sources of Water Supply

The Irrigation Census of 1940 grouped the various sources of water supply into (a) primary sources, i.e., sources from which the principal part or all of the water is obtained for irrigation of the land involved, and (b) supplemental sources, i.e., sources from which a part of the supply of water is obtained to supplement an inadequate "primary" supply. These two groups are, in turn, segregated into the various surface and underground sources.

Water diverted from streams by gravity and/or pumped, and used alone or in connection with water from wells, continues to be the major supply of irrigation water. For detailed breakdown of sources of water supply related to areas, costs, etc., see tables 8 to 11.

The total area reported entirely irrigated from streams was 16,054,903 acres in 1939, comparable to 14,952,049 acres in 1929, or an increase of 7.4 percent. The area reported as irrigated entirely from wells, either pumped or flowing, was 2,570,392 acres in 1939, comparable to 2,117,012 acres in 1929, or an increase of 21.4 percent. However, areas irrigated entirely from flowing wells decreased 14.4 percent, and that from wells, pumped and flowing increased 24.0 percent, indicating additional wells originally flowing are being pumped. This transition is particularly apparent in the States of Utah, New Mexico, and Louisiana. The area reported as irrigated from all sources other than entirely from streams or entirely from wells was 2,378,444 acres in 1939, comparable to 2,478,483 acres in 1929, or a decrease of 4.0 percent.

Areas irrigated entirely from stream diversions increased from 1929 to 1939 in 13 States, and decreased in 6 States. The greatest increases were reported in Wyoming, 267,163 acres, or 22.6 percent; Oregon, 223,880 acres, or 30.3 percent; California, 208,597 acres, or 9.3 percent; Nevada, 186,359 acres, or 47.2 percent; and Montana, 169,747 acres, or 11.4 percent.

The greatest decreases were reported in Colorado, 130,362 acres, or 4.1 percent; and Arizona, 51,053, or 29.9 percent. Areas irrigated entirely from wells, increased in 15 States and decreased in 4 States. The greatest increases were reported in Texas, 204,240 acres, or 326.1 percent; Nebraska, 57,582 acres, or 245.5 percent; and California, 54,342 acres, or 3.7 percent. The greatest decreases were reported in Louisiana, 39,009 acres, or 22.2 percent; and Utah, 3,717 acres, or 18.9 percent.

Areas irrigated entirely from streams, gravity and wells, pumped, 1,252,329 acres in 1939, increased in 14 States and decreased in Idaho, 32,859 acres, or 45.0 percent; and Montana, 1,198 acres, or 44.5 percent. In 1939, the States of North Dakota, Oklahoma, and South Dakota reported no lands irrigated from this source. The net increase for 16 States reporting was 87,980 acres, or 7.6 percent; areas irrigated entirely from springs, 210,373 acres in 1939, decreased 3.2 percent in the 10 years. Of the total acreage irrigated from springs in 1939, Nevada irrigated 54,945 acres; Utah, 35,898 acres; and California, 28,538 acres; representing changes of -11.4 percent, -27.6 percent, and +18.9 percent, respectively.

The 1940 Census of Irrigation segregated the statistics of all enterprises delivering supplemental water to primary enterprises and related the areas served to sources of water supply, i.e., from streams, pumped; wells, pumped or flowing; and streams, gravity or storage, a summary of which is shown in table 3, section C, of this volume.

The 1930 Census of Irrigation segregated statistics only for those enterprises delivering supplemental water from pumped streams, pumped wells, and flowing wells. Therefore, since the major portion of supplemental water is supplied from streams, gravity and storage facilities which were not included in the 1930 Census, the figures shown in table 11 under supplemental water should not be considered comparable between the two Census periods.

TABLE 8.—AREA RECEIVING ENTIRE WATER SUPPLY FROM STREAMS, BY TYPE OF DIVERSION, BY STATES: 1939, 1929, AND 1919

(For the 17 western States and Arkansas and Louisiana)

STATE	TOTAL				STREAMS, GRAVITY				STREAMS, PUMPED				STREAMS, GRAVITY AND PUMPED			
	1939	1929	1919	Increase or decrease 1929-1939	1939	1929	1919	Increase or decrease 1929-1939	1939	1929	1919	Increase or decrease 1929-1939	1939	1929	1919	Increase or decrease 1929-1939
	Acres	Acres	Acres	Percent	Acres	Acres	Acres	Percent	Acres	Acres	Acres	Percent	Acres	Acres	Acres	Percent
Total (19 States)	16,054,903	14,952,049	15,953,165	7.4	13,063,955	12,980,575	14,527,060	0.6	1,724,800	1,713,380	1,226,510	0.7	1,266,148	258,094	199,595	390.6
Arizona	119,744	170,797	198,455	-29.9	71,075	162,621	189,782	-56.3	1,055	8,123	6,671	-87.0	47,614	53	-----	(1)
Arkansas	6,960	1,502	6,129	363.4	-----	-----	120	-----	6,733	1,502	6,009	348.3	-----	227	-----	-----
California	2,463,809	2,254,712	2,920,396	9.3	1,741,575	1,699,599	2,564,445	2.5	470,538	469,944	295,673	0.1	251,196	85,169	60,278	194.9
Colorado	3,039,197	3,189,559	3,050,964	-4.1	3,010,172	3,138,986	3,028,787	-4.1	4,691	27,765	12,747	-83.1	24,334	2,828	9,430	760.5
Idaho	2,097,857	2,029,016	2,384,010	3.4	1,828,663	1,848,760	2,274,959	-11.9	294,402	103,362	107,181	184.8	174,792	76,894	1,870	127.3
Kansas	49,194	56,412	32,137	-12.8	40,902	53,196	30,807	-23.1	8,279	3,216	730	157.4	13	-----	600	-----
Louisiana	249,514	259,001	271,152	-3.7	494	1,611	10,226	-89.3	247,190	257,390	248,306	-4.0	1,830	-----	12,620	-----
Montana	1,487,498	1,487,751	1,550,827	11.4	1,475,894	1,392,161	1,515,212	6.0	55,925	58,620	15,743	-7.0	145,679	56,970	19,872	155.7
Nebraska	511,489	503,653	437,532	1.6	488,499	501,195	435,567	-2.5	10,176	2,458	1,115	314.0	12,814	-----	850	-----
Nevada	581,595	395,236	470,179	47.2	578,163	394,415	466,812	46.6	652	821	2,647	-20.6	2,780	-----	720	-----
New Mexico	417,700	436,955	454,368	-4.4	343,684	430,099	432,478	-20.1	3,887	6,856	1,890	-43.3	70,129	-----	-----	-----
North Dakota	21,432	8,253	11,499	159.7	18,573	6,584	9,030	182.1	2,359	1,669	2,469	41.3	500	-----	-----	-----
Oklahoma	2,794	675	2,710	315.9	1,631	355	2,522	359.4	1,165	320	188	265.4	-----	-----	-----	-----
Oregon	965,449	739,589	851,183	30.3	786,058	674,396	786,354	16.6	45,008	50,537	64,576	-10.9	132,382	14,636	253	804.5
South Dakota	57,061	65,916	95,360	-13.4	20,445	65,855	92,491	-69.0	1,723	61	869	(1)	34,913	-----	-----	-----
Texas	728,678	699,146	495,870	4.2	191,124	168,246	75,982	13.6	525,547	527,700	421,538	-0.4	12,007	3,200	350	275.2
Utah	1,071,609	1,040,577	1,116,130	3.0	906,968	962,568	1,105,691	-5.8	13,445	63,809	10,389	-78.9	151,206	14,200	50	964.8
Washington	585,388	450,067	471,145	25.6	329,397	306,185	352,199	7.6	44,167	139,738	26,244	-68.4	191,824	4,144	92,702	(1)
Wyoming	1,450,415	1,185,252	1,157,121	22.6	1,450,647	1,173,763	1,155,596	21.9	7,860	9,489	1,525	-17.2	11,908	-----	-----	-----

1. Percent not shown when more than 1,000.

GENERAL DISCUSSION

XXXIII

Irrigation Works

Tables 12 to 15 present an inventory of irrigation works, by States, and principal drainage basins for the Censuses of 1940, 1930, and 1920. The marked increase in the number of practically all physical structures during the last decade indicates the installations of betterments and increased efforts to conserve water and develop additional water supplies. Storage dams increased from 2,949 in 1930 to 4,607 in 1940, or 56.2 percent. The number of storage reservoirs increased from 5,122 in 1930 to 7,709 in 1940, or 50.5 percent. The total storage capacity of reservoirs increased from 24,508,590 acre-feet in 1930 to 33,787,382 acre-feet in 1940, or 37.9 percent. Although the number of reservoirs reported decreased in a few States, each irrigation State, except Kansas, shows increased storage capacity. The statistics presented on storage dams and reservoirs for the Census of 1920 include some developments installed for other purposes besides irrigation. Therefore,

in several States, the data are not comparable with those of later censuses when only structures installed primarily for irrigation purposes were included.

Judging from increases in storage capacity, the most important developments in the conservation of water by storage in the decade 1930 to 1940 took place in the States of Arizona, Nebraska, and Utah and in the principal drainage basins of the Missouri, Colorado, and Columbia Rivers and in the Great Basin.

The lengths and capacities of canals show only slight increases, while the lengths of reported pipe lines of all kinds increased from 17,363.1 miles in 1930 to 28,584.9 miles in 1940, or 64.6 percent. The major portion of this increase was concrete pipe lines installed in California, Arizona, and Texas.

The number of flowing wells decreased from 4,811 in 1930 to 4,641 in 1940 and their capacities decreased from 609,367 gallons per minute to 555,073 gallons per minute, or 8.9 percent.

TABLE 12.—NUMBER OF DIVERSION AND STORAGE DAMS, 1940, 1930, AND 1920, BY MATERIALS, 1940; AND NUMBER OF RESERVOIRS WITH CAPACITY, 1940, 1930, AND 1920; BY STATES AND BY PRINCIPAL DRAINAGE BASINS

(For the 17 western States and Arkansas and Louisiana)

ITEM	DIVERSION DAMS							STORAGE DAMS							RESERVOIRS					
	Total			Materials, 1940				Total			Materials, 1940				Total			Capacity		
	1940	1930	1920	Con-crete or ma-sonry	Tim-ber	Earth and rock	All other ¹	1940	1930	1920	Con-crete or ma-sonry	Earth and rock	All other ¹	1940	1930	1920	1940	1930	1920	
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	Acre-ft.	Acre-ft.	Acre-ft.	
Total (19 States)-----	34,544	21,947	23,894	3,666	4,595	18,032	8,251	4,607	2,949	3,931	409	3,795	403	7,709	5,122	7,538	33,787,382	24,508,590	21,246,436	
STATE	BY STATES																			
Arizona-----	602	267	248	84	5	321	192	199	78	99	17	167	15	333	378	340	4,860,898	3,410,975	1,510,856	
Arkansas-----	6	1	63		1	4	1	27	6	17		21	6	24	10	16	31,992	7,342	20	
California-----	2,714	1,654	2,070	527	477	1,111	599	709	421	455	126	531	52	2,652	1,769	3,030	3,581,621	3,225,675	1,091,394	
Colorado-----	4,792	3,672	5,647	367	427	2,858	1,160	1,015	706	803	19	951	45	1,071	765	979	2,071,522	1,924,982	2,406,372	
Idaho-----	3,209	2,305	2,872	536	290	1,964	619	260	152	288	44	185	31	290	155	249	3,795,272	3,645,373	3,493,511	
Kansas-----	102	27	10	16	4	65	17	40	7	13	8	22	10	80	19	36	32,584	66,293	391	
Louisiana-----	105	56	419	3	15	45	42	114	61	63	1	91	22	75	85	74	34,199	13,909	7,632	
Montana-----	6,136	2,856	3,545	254	1,067	3,217	1,598	468	326	523	19	385	64	517	282	468	1,501,422	857,067	1,571,720	
Nebraska-----	351	185	260	76	24	165	86	156	28	73	4	146	6	164	40	59	2,306,159	199,185	197,690	
Nevada-----	1,896	1,640	1,523	95	84	1,077	640	122	118	82	8	110	4	200	209	134	696,005	529,369	504,428	
New Mexico-----	1,072	665	1,423	121	102	475	374	141	69	153	7	124	10	502	240	328	3,280,550	2,945,220	2,960,718	
North Dakota-----	19	9	26		1	14	4	14	10	11		14		14	8	9	3,946	1,466	1,110	
Oklahoma-----	8	4	7	1		6	1	21	3	5	2	18	1	20	7	8	900	293	52	
Oregon-----	5,097	3,806	3,285	665	877	2,220	1,337	247	167	309	35	156	58	257	120	266	2,212,315	1,698,428	1,905,037	
South Dakota-----	258	91	207	13	19	198	28	74	10	182	2	69	3	62	5	119	209,785	203,124	212,264	
Texas-----	244	107	165	76	4	136	28	194	168	134	47	134	13	542	325	368	1,405,024	935,085	392,999	
Utah-----	1,973	1,717	1,479	611	217	778	367	362	287	307	39	513	10	438	413	476	3,417,704	1,093,252	1,600,505	
Washington-----	1,755	499	579	166	453	725	411	125	100	115	21	81	23	114	78	205	1,165,527	699,807	477,789	
Wyoming-----	4,205	2,406	2,066	257	528	2,673	747	319	212	301	12	277	30	334	214	374	5,379,957	3,051,745	2,911,748	
DRAINAGE BASIN	BY PRINCIPAL DRAINAGE BASINS																			
Red River (of the North)-----	5					5		2				2		2			720			
Missouri River-----	8,697	5,006	5,973	673	1,046	5,351	1,827	1,237	734	1,246	33	1,119	85	1,332	743	1,220	6,715,271	4,043,135	4,860,616	
Mississippi River, exclu- sive of Missouri River-----	959	814	1,704	88	58	472	341	360	180	259	17	300	43	425	209	381	1,608,164	1,523,856	1,163,306	
Gulf of Mexico streams, other than Mississippi River and Rio Grande-----	196	99	148	42	11	85	58	204	195	162	43	140	21	436	321	360	334,176	296,264	305,415	
Rio Grande-----	1,450	922	1,639	198	158	670	424	162	99	125	14	137	11	567	306	351	3,664,857	3,120,623	3,233,164	
Colorado River-----	4,391	3,155	2,468	318	489	2,614	970	840	494	565	25	772	43	1,030	734	839	5,717,080	3,748,284	1,676,038	
Whitewater Draw and Vamori Wash. ² -----	158	7	6	1		67	90	6	4	51		6		18	90	76	74	140	85,071	
Great Basin-----	4,263	3,806	5,234	756	441	1,933	1,133	462	409	449	53	395	14	766	787	800	3,781,538	1,922,757	2,289,641	
Columbia River-----	11,208	6,247	6,494	1,066	1,748	5,698	2,696	590	414	603	85	388	117	614	353	646	7,517,123	6,316,670	5,711,783	
Klamath River-----	670	472	505	29	155	292	194	52	20	41	5	40	7	60	52	90	1,165,143	1,110,562	1,022,365	
Sacramento-San Joaquin Delta and tributary streams-----	1,497	781	1,128	555	313	478	371	358	218	285	47	287	24	1,310	949	1,639	2,681,435	2,100,255	677,957	
Pacific Ocean streams, excl. of Gulf of California streams, Columbia and Klamath Rivers, and Sacramento- San Joaquin Delta and tributary streams-----	850	638	595	160	176	367	147	334	182	145	87	209	38	1,149	598	1,136	401,801	326,244	221,080	

¹Other and mixed, and not reported. Other and mixed are principally temporary dams, replaced annually.

²Data for Censuses of 1930 and 1920 are for Whitewater Draw and unidentified tributaries, and do not include the independent basin, Vamori Wash.

GENERAL DISCUSSION

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Number and Yield of Pumped Wells

Table 14 shows the number and yield of wells pumped for irrigation, by States and by principal drainage basins. The total of 68,279 pumped wells reported in 1940 represents a net increase of 11,550 (20.4 percent) for the 19 irrigation States during the decade compared to an increase of 24,635 wells (76.8 percent) during the decade 1920 to 1930.

Yields of pumped wells also increased at the net rate of 33.5 percent in the last decade compared to 98.0 percent increase during the previous decade. The average yield per well was 635 gallons per minute in 1940 as compared to 572 gallons per minute in 1930, which indicates that larger wells are being developed with the more modern drilling and pumping equipment available.

Each of the 19 irrigation States, excepting Utah, shows an increase for 1940 contrasted with 1930 in number of wells

pumped while the reported yields decreased in Louisiana (22.1 percent), Nevada (6.0 percent), and Washington (6.3 percent). The greatest increases in number of pumped wells were reported for Texas (2,294), Colorado (2,224), Nebraska (1,875), and California (1,831). The greatest increases in yields, gallons per minute, were in California with 4,031,802; Colorado with 1,891,895; Nebraska with 1,625,126; and Texas with 1,598,835. These yields raised the average per well in these States as follows: California, from 519 gallons per minute to 583; Colorado, from 364 gallons per minute to 670; Nebraska, from 797 gallons per minute to 851; and Texas, from 558 gallons per minute to 652.

The number of pumped wells increased (1930-40) in all principal drainage basins, excluding Red River of the North, N. Dak.; Whitewater Draw, and Vamori Wash, Ariz.; and the Great Basin which shows a decrease of 1,401 wells, or 51.8 percent, representing a decrease of 50.6 percent in total yield.

TABLE 14.—NUMBER AND YIELD OF PUMPED WELLS, BY STATES AND BY PRINCIPAL DRAINAGE BASINS: 1940, 1930, AND 1920

(For the 17 western States and Arkansas and Louisiana)

ITEM	PUMPED WELLS													
	Number							Yield						
	1940	1930	1920	Increase or decrease (-)				1940	1930	1920	Increase or decrease (-)			
				1930-1940		1920-1930					1930-1940		1920-1930	
				Number	Percent	Number	Percent				G.p.m.	Percent	G.p.m.	Percent
Total (19 States)	68,279	56,729	32,094	11,550	20.4	24,635	76.8	43,355,271	32,467,120	16,596,549	10,888,151	33.5	16,070,571	98.0
STATE	BY STATES													
Arizona	1,858	1,398	999	460	32.9	399	39.9	2,508,337	1,852,352	1,042,580	675,965	36.9	789,762	75.8
Arkansas	1,534	1,190	1,089	544	28.9	101	9.5	1,812,647	1,641,448	1,470,147	171,199	10.4	171,301	11.7
California	48,568	46,757	25,401	1,831	3.9	21,536	84.0	28,297,969	24,266,167	10,608,476	4,031,802	16.6	13,657,691	128.8
Colorado	2,878	654	527	2,224	340.1	127	24.1	1,929,798	237,903	210,094	1,691,895	711.2	27,809	13.2
Idaho	309	121	53	188	155.4	68	128.5	225,164	34,601	17,749	190,563	550.7	16,852	94.9
Kansas	1,638	772	710	866	112.2	62	8.7	863,663	323,500	266,797	540,163	167.0	56,703	21.5
Louisiana	1,504	1,589	812	115	8.3	577	71.1	1,526,613	1,958,811	1,607,637	-452,198	-22.1	351,174	21.8
Montana	102	49	22	53	108.2	27	122.7	33,883	18,653	11,085	15,250	81.6	7,568	68.3
Nebraska	2,412	537	54	1,875	349.2	503	(1)	2,053,184	428,058	24,701	1,625,126	379.7	403,357	(1)
Nevada	167	147	129	20	13.6	18	14.0	50,958	54,162	6,798	-3,224	-6.0	47,364	696.7
New Mexico	1,487	680	461	807	118.7	219	47.5	1,143,276	481,898	265,618	661,578	157.2	216,280	81.4
North Dakota	11	—	—	11	—	—	—	378	—	—	378	—	—	—
Oklahoma	77	18	19	59	327.8	-1	-5.3	15,486	2,715	3,643	12,771	470.4	-928	-25.5
Oregon	901	558	208	343	61.5	350	168.3	209,289	156,669	47,026	72,620	53.1	89,645	190.6
South Dakota	16	1	1	15	(1)	—	—	1,039	375	800	664	177.1	-425	-53.1
Texas	3,396	1,102	901	2,294	208.2	201	22.3	2,213,230	614,395	538,565	1,598,655	260.2	75,850	14.1
Utah	286	346	192	-60	-17.5	154	80.2	122,528	120,333	59,059	2,195	1.8	81,274	208.1
Washington	1,041	1,019	520	22	2.2	499	96.0	287,327	306,800	227,744	-19,473	-6.3	79,056	34.7
Wyoming	94	11	16	83	754.5	-5	-31.3	60,522	8,280	8,020	52,242	650.9	260	3.2
DRAINAGE BASIN	BY PRINCIPAL DRAINAGE BASINS													
Missouri River	4,760	1,071	585	3,689	344.4	686	178.2	3,653,499	613,550	171,464	3,020,149	492.4	441,886	257.7
Mississippi River, exclusive of Missouri River	4,428	2,216	2,085	2,212	99.8	131	6.3	3,493,820	2,104,316	1,876,840	1,589,504	66.0	227,476	12.1
Gulf of Mexico streams, other than Mississippi River and Rio Grande	4,158	2,565	1,615	1,795	76.0	748	46.3	3,210,783	2,493,111	2,072,580	717,672	28.8	420,531	20.3
Rio Grande	1,712	751	503	981	134.2	228	45.3	1,291,071	498,631	286,143	792,440	158.9	212,488	74.3
Colorado River	2,395	1,196	1,128	1,199	100.5	68	6.0	2,758,983	1,772,812	1,095,724	986,171	55.6	677,088	61.8
Whitewater Draw and Vamori Wash ²	142	210	209	-68	-32.4	1	0.5	45,537	62,457	72,787	-16,920	-27.1	-10,330	-14.2
Great Basin	1,506	2,707	870	-1,401	-51.8	1,837	211.1	653,078	1,321,396	275,094	-668,518	-50.6	1,048,302	385.9
Columbia River	1,972	1,653	752	309	18.6	911	121.1	687,659	464,026	277,555	223,613	48.2	186,471	67.2
Klamath River	56	14	16	42	500.0	-2	-12.5	29,509	21,442	5,975	8,067	37.6	15,467	258.9
Sacramento-San Joaquin Delta and tributary streams	52,418	51,744	14,657	674	2.1	17,087	116.6	20,042,293	16,750,369	6,384,882	3,311,924	19.8	10,345,487	162.0
Pacific Ocean streams, excl. of Gulf of California streams, Columbia and Klamath Rivers, and Sacramento-San Joaquin Delta and tributary streams	14,932	12,814	9,874	2,118	16.5	2,940	29.8	7,509,059	6,385,210	3,879,505	1,123,849	17.6	2,505,705	64.6

¹ Percent not shown when more than 1,000.

² Data for Censuses of 1930 and 1920 are for Whitewater Draw and unidentified tributaries, and do not include the independent basin, Vamori Wash.

Pumping Equipment

Table 15 presents comparable statistics on pumping equipment for the Censuses of 1940, 1930, and 1920, by kind of power, kind of pump, and capacities by States and principal drainage basins. The average pumping lift is also shown.

The total installed horsepower for pumping water for irrigation in the 19 States increased from 1,283,419 horsepower to 1,762,687 horsepower, or 37.3 percent during the decade 1930 to 1940. Likewise, the pumps installed increased 27.8 percent

in number and 32.4 percent in capacity. The average pumping lift reported for all pumping plants remains static for the decade at 51 feet.

Since 1930 the use of electric power increased by 241,858 installed horsepower and represents 63.4 percent of the total in 1940. The installed horsepower of internal-combustion engines increased 322,387 horsepower and represents 63.4 percent of the total.

A marked increase (13,370 to 38,204 or 185.7 percent) took place in the installation of turbine pumps during the decade.

Since this type of pump is used almost exclusively for the pumping of water from wells and there was no substantial reduction in the use of other types of pumps, it can be reasoned that the trend is toward turbine pumps and the increased number of turbine pumps is indicative of new developments since 1930 involving pumped wells. Although turbine pumps lead in total number and require 51.1 percent of the total installed motive power, centrifugal pumps exceed in capacity with 55.4 percent of the total. The average lift for centrifugal pumps is 29 feet compared with 70 feet for the turbines. This higher lift largely accounts for the greater horsepower required by the turbine installations. It is notable that the total number of centrifugal pumps decreased slightly. However, the total capacity increased 10.1 percent and the installed horsepower decreased 17.8 percent, indicating replacements of machinery of higher efficiency.

All States show a marked decade increase in the installation of pumping equipment, with the exception of Utah (-11.1 percent). California, with 52,016 pumps or 66.1 percent of the total installations ranks first, followed in order by Texas, 6.1 percent, and Colorado and Nebraska, each with 3.6 percent of the total. Marked increases in reported average lifts are shown in Arizona and Texas.

Pumping plant installations in the principal drainage basins, exclusive of Red River and Whitewater Draw and Vamori Wash, increased, with the exception of the Great Basin (-48.1 percent). The Sacramento-San Joaquin Delta and tributary basins contain 44.3 percent of the total irrigation pumps in the 19 States. Other Pacific Ocean basins exclusive of the Colorado, Columbia, and Klamath Basins, rank second, with 21.1 percent, and the Missouri River Basin ranks third, with 7.6 percent of the total number of pumps installed. However, the Gulf of Mexico streams other than the Mississippi and Rio Grande rank third in installed horsepower and second in capacity of pumps.

TABLE 15.—PUMPING EQUIPMENT—BY KIND OF POWER, BY KIND OF PUMP, BY STATES, AND BY PRINCIPAL DRAINAGE BASINS:
1940, 1930, AND 1920

(For the 17 western States and Arkansas and Louisiana)

ITEM (For definitions and explanations, see text)	CAPACITY OF PRIME MOVERS						PUMPS												Average pumping lift		
	1940	1930	1920	Pro- portion of total, 1940	In- crease or de- crease (-) 1930- 1940	Total					Capacity					1940	1930	1920			
						1940	1930	1920	Pro- portion of total, 1940	In- crease or de- crease (-) 1930- 1940	1940	1930	1920	Pro- portion of total, 1940	In- crease or de- crease (-) 1930- 1940						
Hp.	Hp.	Hp.	Percent	Percent	Number	Number	Number	Percent	Percent	G.p.m.	G.p.m.	G.p.m.	Percent	Percent	Feet	Feet	Feet				
Total (19 States)	1,762,687	1,283,419	748,971	100.0	37.3	78,528	61,445	33,804	100.0	27.8	75,802,998	57,244,859	56,275,005	100.0	32.4	51	51	41			
BY KIND OF POWER																					
Electric motor	1,118,024	876,166	289,018	63.4	27.6	50,597	44,165	12,743	64.5	14.6	43,527,320	37,365,179	13,311,435	57.4	16.5	55	57	50			
Internal-combustion engine	588,123	285,736	259,613	33.4	121.3	21,533	13,012	15,891	27.4	65.5	20,532,240	10,891,855	10,461,957	27.1	88.5	42	37	35			
Other	56,540	50,343	125,429	3.2	12.3	1,213	874	2,515	1.5	38.8	1,842,277	3,245,151	7,986,226	2.4	-43.2	63	40	37			
Mixed	(1)	91,174	74,911			5,185	3,394	3,055	6.6	52.8	9,901,161	5,742,674	4,515,487	13.1	72.4	50	45	46			
BY KIND OF PUMP																					
Centrifugal	597,067	726,301	581,274	33.9	-17.8	34,447	54,803	26,019	43.9	-1.0	42,056,392	58,193,371	29,250,062	55.4	10.1	29	36	33			
Turbine	901,137	302,294	24,390	51.1	198.1	38,204	13,370	677	48.6	185.7	30,746,028	8,655,509	525,728	40.6	255.2	70	75	84			
Plunger	17,553	17,503	(2)	1.0	0.3	4,887	2,867	(2)	6.2	70.5	299,420	272,174	(2)	0.4	10.0	80	101	(2)			
Other and mixed	246,930	237,321	214,307	14.0	121.5	990	10,405	27,108	1.3	-79.6	2,721,158	10,123,805	26,499,215	3.6	-55.8	40	65	268			
BY STATES																					
Arizona	102,733	57,633	22,014	5.8	78.3	1,969	1,364	1,001	2.5	44.4	2,992,986	2,125,293	1,048,030	3.9	40.8	60	46	44			
Arkansas	76,048	66,980	58,332	4.3	13.5	1,633	1,206	1,121	2.1	35.4	2,013,697	1,775,788	1,654,097	2.7	13.4	61	68	50			
California	968,351	820,787	386,200	54.9	18.0	52,016	47,994	24,134	66.1	8.4	59,147,470	33,240,589	16,773,692	51.7	17.8	55	53	41			
Colorado	49,157	11,204	8,635	2.8	338.7	2,618	540	435	3.6	421.9	2,263,375	457,250	299,728	3.0	417.6	32	25	23			
Idaho	44,537	33,754	28,364	2.5	31.9	675	465	232	0.9	45.2	2,719,905	2,113,513	1,397,681	3.6	28.7	26	32	29			
Kansas	26,796	6,221	6,946	1.5	330.7	1,259	312	286	1.6	303.5	1,231,482	393,526	297,975	1.6	212.9	35	26	30			
Louisiana	85,574	86,413	85,628	4.9	-1.0	2,403	2,000	1,941	3.1	20.2	6,455,487	5,914,799	4,988,686	8.5	9.1	32	37	32			
Montana	29,110	9,095	10,341	1.7	220.1	680	233	299	0.9	191.8	1,309,014	523,494	453,231	1.7	150.1	21	22	20			
Nebraska	53,572	10,991	959	3.0	387.4	2,648	636	54	3.6	347.8	2,528,669	536,752	73,686	3.3	371.1	32	29	24			
Nevada	2,262	2,671	409	0.1	-15.3	196	173	72	0.2	13.3	141,085	115,648	35,266	0.2	22.0	31	31	22			
New Mexico	40,110	14,483	8,488	2.3	176.9	1,559	738	491	2.0	111.2	1,309,005	555,063	304,789	1.7	135.8	44	40	40			
North Dakota	1,253	218	2,068	0.1	480.1	83	13	10	0.1	538.5	104,158	24,900	51,250	0.1	318.3	17	24	38			
Oklahoma	1,037	229	184	0.1	352.8	116	30	26	0.1	286.7	59,280	8,855	7,688	0.1	569.5	36	33	59			
Oregon	29,527	21,257	13,769	1.7	38.8	2,265	1,157	614	2.9	95.8	1,510,958	1,022,213	600,045	2.0	47.8	27	27	28			
South Dakota	2,060	92	498	0.1	(3)	127	8	25	0.2	(3)	103,050	4,027	23,320	0.1	(3)	20	27	21			
Texas	195,061	95,933	80,511	11.1	103.3	4,754	2,028	1,641	6.1	134.4	9,916,225	6,494,999	6,825,998	13.1	52.7	89	55	45			
Utah	14,216	11,361	11,392	0.8	24.9	409	480	291	0.5	-11.1	855,862	877,942	783,588	1.1	-4.8	35	36	25			
Washington	37,131	33,187	22,929	2.1	11.9	2,488	2,023	1,059	3.2	23.0	953,751	993,303	656,552	1.3	-4.0	47	59	80			
Wyoming	4,152	912	1,304	0.2	355.3	230	65	70	0.3	253.8	209,559	86,905	59,725	0.3	141.1	30	21	31			
BY PRINCIPAL DRAINAGE BASINS																					
Red River (of the North)	274	153	—	(4)	79.1	16	8	—	(4)	100.0	26,045	20,400	—	(4)	27.7	21	13	—			
Missouri River	117,173	25,788	18,329	6.6	354.4	5,994	1,279	889	7.6	368.6	5,733,010	1,343,545	800,218	7.6	328.7	52	26	22			
Mississippi River, exclu- sive of Missouri River	145,750	78,378	73,739	8.3	86.0	4,190	1,804	1,715	5.3	132.3	4,275,330	2,418,238	2,237,441	5.6	76.8	57	54	45			
Gulf of Mexico streams, other than Mississippi River and Rio Grande	208,930	140,298	136,955	11.9	48.9	5,697	3,525	3,208	7.3	61.6	11,846,141	8,929,951	9,202,748	15.4	30.4	50	46	37			
Rio Grande	76,569	52,910	30,941	4.3	44.7	2,355	1,099	709	3.0	114.1	5,486,952	3,981,586	2,716,936	7.2	41.4	42	41	42			
Colorado River	117,403	62,050	27,406	6.7	89.2	2,640	1,220	1,128	3.4	116.4	5,616,220	2,367,101	1,195,680	4.8	52.8	54	44	42			
Whitewater Draw and Vamori Wash	2,070	2,025	2,403	0.1	2.2	144	215	209	0.2	-33.0	63,344	59,507	73,987	0.1	6.4	57	48	44			
Great Basin	39,973	62,344	20,603	2.3	-35.9	1,448	2,788	820	1.8	-48.1	1,514,748	3,205,814	1,035,964	2.0	-52.8	71	67	41			
Columbia River	105,911	77,271	62,451	6.0	37.1	4,439	3,434	1,745	5.7	29.3	4,609,862	3,593,854	2,522,910	6.1	28.3	39	47	50			
Klamath River	6,854	6,522	3,996	0.4	5.1	224	123	83	0.3	82.1	506,460	508,965	174,184	0.7	-0.5	26	33	25			
Sacramento-San Joaquin Delta and tributary streams	552,193	468,661	201,074	31.3	17.8	34,831	33,129	14,849	44.3	5.1	29,694,592	23,856,244	11,584,371	39.1	24.5	42	42	32			
Pacific Ocean streams, excl. of Gulf of Cali- fornia streams, Columbia and Klamath Rivers, and Sacramento-San Joaquin Delta and tributary streams	389,587	307,019	171,076	22.1	26.9	16,552	12,821	8,649	21.1	29.1	8,630,296	7,059,634	4,732,586	11.4	22.2	80	79	58			

1 For 1940 mixed types of motors were segregated and assigned to the proper types. 1930 and 1920 data include "Not reported." 2 Data for "Plunger" pumps included with "Other and mixed" pumps for 1920. 3 Percent not shown when more than 1,000. 4 Less than one-tenth of 1 percent. 5 Data for Censuses of 1930 and 1920 are for Whitewater Draw and unidentified tributaries, and do not include the independent basin, Vamori Wash.

GENERAL DISCUSSION

XXXVII

Capability of Irrigation Works

Table 16 shows the areas which installed irrigation works were reported capable of supplying with water and irrigable areas reported, together with the excess of these areas over areas irrigated. The expansion possibilities from the standpoint of capacity of irrigation works are thus indicated. Of the 10,302,210 acres of irrigable land now in irrigation projects which were not irrigated in 1939, statistics indicate that 7,051,509 acres could be irrigated with the present systems, leaving 3,250,701 acres of irrigable land in operating enterprises for which works have not been constructed. Cali-

formia with constructed irrigation works capable of supplying water to 2,329,008 acres more than were irrigated in 1939. Texas with 728,588 acres, Colorado with 692,857 acres, and Montana with 632,981 acres, are the States with the greatest acreages under works but not irrigated. Similarly, the Sacramento and San Joaquin Valleys of California with works capable of supplying water to 1,738,715 acres more than were irrigated in 1939, the Missouri River with 1,532,573 acres, the Colorado River with 729,624 acres, and the Rio Grande with 656,129 acres, indicate the locations of largest areas by drainage basins under irrigation works but not irrigated in 1939.

TABLE 16.—AREA IRRIGATION WORKS WERE CAPABLE OF SUPPLYING WITH WATER, AND IRRIGABLE AREA, 1940, 1930, AND 1920; AND THE EXCESS OF THESE AREAS OVER AREAS IRRIGATED, 1939, 1929, AND 1919; BY STATES AND BY PRINCIPAL DRAINAGE BASINS

(For the 17 western States and Arkansas and Louisiana)

ITEM	AREA WORKS WERE CAPABLE OF SUPPLYING WITH WATER							IRRIGABLE AREA						
	1940		1930		1920		Increase or decrease (-) of excess over area irrigated 1930-1940	1940		1930		1920		Increase or decrease (-) of excess over area irrigated 1930-1940
	Area	Excess over area irrigated in 1939	Area	Excess over area irrigated in 1929	Area	Excess over area irrigated in 1919		Area	Excess over area irrigated in 1939	Area	Excess over area irrigated in 1929	Area	Excess over area irrigated in 1919	
	Acres	Acres	Acres	Acres	Acres	Acres	Percent	Acres	Acres	Acres	Acres	Acres	Acres	Percent
Total (19 States)	28,055,248	7,051,509	28,101,890	6,554,346	26,020,477	6,828,761	7.6	31,305,949	10,302,210	30,599,470	11,051,926	35,890,821	16,699,105	-6.8
STATE	BY STATES													
Arizona	844,212	190,949	824,152	248,562	627,303	159,738	-23.2	1,104,645	451,382	1,085,627	510,037	813,153	345,588	-11.5
Arkansas	287,765	126,164	209,942	58,155	179,013	35,087	116.9	314,929	153,328	225,992	74,205	246,480	102,534	106.6
California	7,398,576	2,329,008	6,815,250	2,068,618	5,894,466	1,675,426	12.6	8,039,175	2,969,607	8,075,895	3,329,263	7,805,207	3,586,187	-10.8
Colorado	3,913,542	692,857	4,078,712	685,093	3,855,348	506,963	1.1	4,283,250	1,062,565	4,528,251	1,134,632	5,220,588	1,872,203	-6.4
Idaho	2,593,534	315,677	2,617,021	435,771	3,092,810	604,004	-27.6	2,870,023	592,166	2,814,048	632,798	3,780,048	1,291,242	-6.4
Kansas	142,409	42,429	85,583	12,295	67,853	20,541	245.1	147,226	47,246	95,719	24,429	102,562	55,250	93.4
Louisiana	759,915	312,820	795,165	344,264	728,742	273,860	-9.1	793,674	346,579	850,401	399,500	851,211	396,329	-13.2
Montana	2,344,390	632,981	2,276,000	681,088	2,753,498	1,071,769	-7.1	2,588,214	876,605	2,622,423	1,027,511	4,329,148	2,647,419	-14.7
Nebraska	982,957	382,578	705,641	171,024	562,468	119,778	123.7	1,095,567	495,188	765,039	250,422	768,768	324,078	110.6
Nevada	841,304	101,441	736,249	249,601	704,708	143,261	-59.4	915,689	175,826	983,717	497,069	1,382,056	820,589	-64.6
New Mexico	731,990	177,951	656,669	129,636	696,119	157,742	37.3	807,656	253,617	741,245	214,212	961,879	423,502	18.4
North Dakota	36,522	14,907	24,006	14,614	34,235	22,165	0.2	39,558	17,943	24,860	15,468	57,476	45,404	16.0
Oklahoma	8,624	4,464	7,331	5,758	9,672	6,703	-22.5	13,494	9,334	7,344	5,771	11,742	8,773	61.7
Oregon	1,261,081	211,905	1,158,210	259,497	1,344,046	357,884	-18.3	1,441,417	392,241	1,478,128	579,415	1,925,987	939,825	-32.3
South Dakota	121,847	61,649	109,550	42,443	150,914	50,232	45.3	123,961	63,763	122,510	55,403	188,382	87,700	15.1
Texas	1,773,812	728,588	1,177,415	378,498	1,150,542	564,422	92.5	2,180,796	1,155,572	1,566,876	767,959	1,687,447	1,101,327	47.9
Utah	1,357,714	181,598	1,542,475	218,350	1,700,550	388,899	-16.8	1,432,533	256,417	1,739,869	415,744	2,559,244	987,593	-38.3
Washington	731,527	116,514	631,511	132,228	637,151	107,252	-11.9	837,096	222,083	915,379	416,096	836,795	306,896	-46.6
Wyoming	1,913,527	427,029	1,655,008	418,853	1,831,039	623,057	2.0	2,277,046	790,548	1,958,147	721,992	2,564,668	1,356,686	9.5
DRAINAGE BASIN	BY PRINCIPAL DRAINAGE BASINS													
Red River (of the North)	7,980	3,487	2,099					8,100	3,607	2,409	310			(1)
Missouri River	5,942,958	1,532,573	5,472,012	1,286,832	5,805,630	1,658,352	19.1	6,542,576	2,132,191	6,251,873	2,046,693	8,483,171	4,335,893	4.2
Mississippi River, exclusive of Missouri River	1,350,911	423,317	1,170,583	268,023	1,152,261	193,768	57.9	1,458,502	530,906	1,280,730	378,170	1,543,064	584,571	40.4
Gulf of Mexico streams, other than Mississippi River and Rio Grande	1,520,796	618,404	1,221,997	559,039	1,157,529	459,452	10.6	1,874,654	972,262	1,536,404	873,446	1,602,169	904,092	11.3
Rio Grande	2,177,705	656,127	1,914,781	550,056	1,914,285	601,430	87.4	2,378,063	856,485	2,177,664	612,939	2,628,153	1,315,298	39.7
Colorado River	3,567,744	729,624	3,335,914	798,790	3,009,219	682,529	-8.7	4,017,757	1,379,637	4,435,529	1,898,405	4,102,096	1,775,406	-27.3
Whitewater Draw and Vamori Wash	13,462	4,964	4,753	1,452	9,950	4,079	241.9	14,261	5,763	5,570	2,269	16,623	10,752	154.0
Great Basin	2,381,171	307,444	2,536,492	500,459	2,825,313	547,662	-38.6	2,504,611	430,884	3,004,651	968,618	4,165,450	1,887,799	-55.5
Columbia River	4,426,367	606,629	4,241,244	847,604	4,968,518	1,095,273	-28.4	5,001,483	1,181,745	4,992,131	1,596,491	6,336,601	2,463,556	-26.1
Klamath River	310,560	59,522	264,949	76,958	205,374	52,269	-48.6	384,003	112,965	316,239	128,248	362,793	209,688	-11.9
Sacramento-San Joaquin Delta and tributary streams	5,132,597	1,738,715	4,795,836	1,638,704	4,113,524	1,368,880	6.1	5,680,337	2,266,455	5,595,666	2,236,534	5,499,735	2,755,091	1.3
Pacific Ocean streams, excl. of Gulf of California streams, Columbia and Klamath Rivers, and Sacramento-San Joaquin Delta and tributary streams	1,422,997	390,703	1,141,230	226,429	858,874	165,067	72.5	1,461,602	429,308	1,222,604	307,803	1,150,766	456,959	39.5

¹ Percent not shown when more than 1,000.

² Data for Censuses of 1930 and 1920 are for Whitewater Draw and unidentified tributaries, and do not include the independent basin, Vamori Wash.

GENERAL DISCUSSION

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TABLE 18.—WATER USED PER ACRE IRRIGATED FROM SURFACE SOURCES, 1939 AND 1929; AND FROM UNDERGROUND SOURCES, 1939; BY PRIMARY AND SUPPLEMENTAL ENTERPRISES, AND BY STATES
(For the 17 western States and Arkansas and Louisiana)

STATE	QUANTITY OF WATER ENTERING CANALS PER ACRE IRRIGATED			QUANTITY OF WATER DELIVERED TO IRRIGATORS PER ACRE IRRIGATED				
	1939		1929 ¹	1939				1929 ¹
	Primary enterprises	Supplemental enterprises	Primary enterprises	Primary enterprises		Supplemental enterprises		Primary enterprises
	Surface sources	Surface sources	Surface sources	Surface sources	Underground sources	Surface sources	Underground sources	Surface sources
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
TOTAL								
Average (19 States)-----	4.5	1.7	4.1	2.8	2.5	1.3	1.9	2.8
Arizona-----	7.6	-----	5.8	3.2	3.4	1.0	1.6	3.1
Arkansas-----	2.0	-----	(2)	2.6	2.8	0.7	2.8	(2)
California-----	4.3	1.4	4.0	2.6	2.7	1.5	1.9	2.8
Colorado-----	2.5	0.8	2.8	2.4	2.2	0.6	1.8	1.8
Idaho-----	7.9	2.6	5.9	4.1	2.9	1.2	1.8	4.1
Kansas-----	1.4	-----	(2)	1.3	1.6	0.2	2.0	(2)
Louisiana-----	3.4	-----	2.8	2.7	2.1	1.6	0.8	1.6
Montana-----	3.4	2.1	4.3	2.1	2.1	1.3	3.0	1.7
Nebraska-----	3.8	4.9	4.1	2.0	1.5	0.5	0.8	3.0
Nevada-----	5.1	3.5	4.0	3.0	4.6	3.5	1.8	3.1
New Mexico-----	6.4	-----	5.8	3.2	2.6	1.1	1.5	2.1
North Dakota-----	4.5	-----	6.1	1.8	0.4	-----	-----	1.6
Oklahoma-----	0.8	-----	(2)	1.2	2.0	-----	-----	(2)
Oregon-----	5.3	1.2	4.8	3.3	2.0	2.1	5.6	3.1
South Dakota-----	2.1	-----	3.8	1.1	0.4	-----	-----	1.3
Texas-----	5.2	4.8	3.5	2.7	1.4	1.4	1.4	1.7
Utah-----	2.9	1.2	3.5	2.5	3.5	1.1	2.0	2.4
Washington-----	5.7	2.0	5.4	4.3	4.2	3.8	2.7	3.6
Wyoming-----	4.4	1.1	3.2	2.1	1.9	0.8	0.2	2.5
MEASURED ¹								
Average (19 States)-----	4.5	1.6	4.0	2.8	2.4	2.0	1.3	2.8
Arizona-----	7.9	-----	5.7	3.2	3.0	-----	-----	2.9
Arkansas-----	-----	-----	(2)	-----	-----	-----	-----	(2)
California-----	4.4	2.0	4.0	2.4	1.9	1.8	1.2	2.7
Colorado-----	2.4	0.7	2.4	1.6	1.3	0.7	-----	1.8
Idaho-----	7.4	2.6	5.5	5.1	3.2	6.1	2.2	4.1
Kansas-----	1.2	-----	(2)	1.3	-----	-----	-----	(2)
Louisiana-----	-----	-----	(2)	-----	-----	-----	-----	(2)
Montana-----	3.3	2.1	3.2	1.9	-----	1.3	-----	1.6
Nebraska-----	3.4	4.9	4.2	1.9	-----	0.5	-----	3.1
Nevada-----	5.2	5.4	4.0	4.2	-----	3.3	-----	3.1
New Mexico-----	6.2	-----	6.2	2.8	2.4	-----	-----	2.1
North Dakota-----	5.3	-----	6.1	-----	-----	-----	-----	1.6
Oklahoma-----	0.8	-----	(2)	-----	0.5	-----	-----	(2)
Oregon-----	5.3	1.3	5.2	4.2	0.4	0.7	-----	3.2
South Dakota-----	2.2	-----	3.6	1.0	-----	-----	-----	(2)
Texas-----	5.6	-----	4.8	2.9	1.8	0.9	-----	2.6
Utah-----	3.0	1.1	2.7	2.4	4.3	1.1	-----	2.4
Washington-----	5.6	0.7	5.3	4.1	4.6	1.5	-----	3.6
Wyoming-----	5.4	1.1	2.8	3.6	-----	0.9	-----	2.0
NOT MEASURED								
Average (19 States)-----	4.4	2.0	4.4	2.7	2.6	0.9	1.9	2.6
Arizona-----	5.5	-----	7.8	3.4	4.0	1.0	1.6	5.3
Arkansas-----	2.0	-----	(2)	2.6	2.8	0.7	2.8	(2)
California-----	3.7	1.0	3.6	2.9	2.8	1.1	1.9	3.2
Colorado-----	2.9	0.9	3.8	4.2	2.2	0.6	1.8	2.1
Idaho-----	12.0	2.4	7.2	2.3	2.6	0.2	1.7	4.9
Kansas-----	1.8	-----	(2)	1.2	1.6	0.2	2.0	(2)
Louisiana-----	3.4	-----	2.8	2.7	2.1	1.6	0.8	1.6
Montana-----	3.5	1.8	5.2	2.2	2.1	1.1	3.0	1.8
Nebraska-----	8.0	-----	1.8	2.1	1.5	0.5	0.8	1.8
Nevada-----	4.9	3.1	4.6	2.6	4.6	4.3	1.8	3.2
New Mexico-----	6.5	-----	5.3	3.4	2.6	1.1	1.5	1.4
North Dakota-----	1.9	-----	(2)	1.8	0.4	-----	-----	(2)
Oklahoma-----	-----	-----	(2)	1.2	2.1	-----	-----	(2)
Oregon-----	5.3	0.9	4.1	2.9	2.1	2.2	5.6	2.3
South Dakota-----	1.5	-----	5.9	1.6	0.4	-----	-----	1.3
Texas-----	4.7	4.8	2.5	2.7	1.4	2.1	1.1	1.5
Utah-----	2.6	1.4	4.5	2.6	3.4	1.1	2.0	2.6
Washington-----	5.9	6.7	5.9	4.5	4.1	4.0	2.7	3.5
Wyoming-----	3.4	1.0	3.5	1.7	1.9	0.8	0.2	3.4

¹ Data only for enterprises serving 5 or more units. Water and area for surface and underground sources and water and area for primary and supplemental enterprises were not segregated in 1929.
² Not reported.

Areas by Types of Water Rights

Table 19 (p. XLV) presents a proportional table by States based on the areas irrigated by enterprises reporting different types of water rights. The indicated decrease in the proportion of acreages reporting water rights adjudicated by court in 1939 is probably due largely to the fact that a direct question calling for a report on adjudicated rights was not placed on the questionnaire presented to the enterprises. Therefore, in many instances, appropriated, underground, or other rights,

were not specified by the enterprise reporting as rights having been also adjudicated by court decree.

The considerable increase in water rights reported as underground, in the States of Arizona, Kansas, Nebraska, and Texas, harmonizes substantially with the increases of areas irrigated from wells in these States as set forth in table 9. Lands irrigated from wells show a decade increase in Arizona of 40,494 acres; Kansas, 33,407 acres; Nebraska, 57,582 acres; and Texas, 204,240 acres. A further discussion of water rights and laws pertaining to water rights by States is presented on page XL.

Water may be diverted from a natural source of supply for irrigation or other useful purposes only by virtue of a right of use, called a water right. Water rights of various types are defined or recognized by legislation and court decisions in all of the 17 Western States, all of which are included in the irrigation census, and the States have assumed greater or less control over the acquisition and exercise of rights of certain types. In the 3 other States included in the irrigation census of 1940—Arkansas, Florida, and Louisiana—there is as yet no water-right legislation, and rights to the use of water have not yet been defined clearly even by the courts.

Surface sources.—The two types of water right that apply to the use of water of surface streams are the appropriative right and the riparian right. Under the appropriation doctrine, the first user of water acquires a right to continue the use, which right is prior to the right of every subsequent user from the same source of supply, and each one who begins use thereafter is junior in right to all those who preceded him and is senior to all those whose rights are acquired later. Under the riparian doctrine, the owner of land that is contiguous to a stream has certain rights in the flow of water for use on his riparian land, solely by virtue of such land ownership, and no priority over other riparian owners is acquired by the first user.

Appropriation doctrine.—All of the 17 western States have adopted the doctrine of appropriation and have provided by statute for the appropriation of water from specified sources, such as watercourses and springs, under designated procedures. The current procedure in most States includes an application to a State official, and approval thereof, which becomes a permit to make the appropriation, followed by steps that result in perfecting the right upon making proof that the water has been put to beneficial use. The date of filing the application in the State office is the date of priority of the appropriation, provided all subsequent steps are taken in full compliance with the statute and regulations for administering the statute. The value of the priority lies in the fact that the requirements of the appropriator for water covered by his appropriation must be satisfied fully from the available supply before the holder of any subsequent priority is entitled to divert water from the same source.

Prior to the enactment of the present water codes, the usual procedure under the then existing statute of a State or Territory was to post a notice at the proposed point of diversion of water, and to file a copy in the county records. The priority of such an appropriation dated from the initial step, provided that the construction work was completed and the water applied to the land with reasonable diligence, but if the appropriator was not diligent, the priority dated from the completion of the appropriation.

Appropriations now in effect are equally valid, whether made before or after the enactment of the present water codes, provided they were completed in accordance with whatever statute was in effect at the time of the appropriation, and provided that they have not since been abandoned or otherwise lost by prescription or by forfeiture through failure to exercise the right for a definite number of years prescribed by statute.

Riparian doctrine.—Some of the western States recognize the riparian doctrine concurrently with the doctrine of appropriation. The riparian right is inherent in the ownership of riparian land and therefore is not acquired by applying to the State for a permit to make use of the water. Nor is the right lost by failure to use the water, but it can be lost by adverse use on the part of others upstream for a period of years prescribed by the statute of limitations.

The riparian doctrine has been repudiated wholly in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; hence (with minor exceptions in Nevada, as noted below), water rights applicable to surface streams in those States are subject entirely to the appropriation doctrine. In Oregon the riparian doctrine has been so restricted by statute and court decisions as to amount to practical abrogation. In Oklahoma it is assumed that the riparian doctrine is in effect in some degree, but its status is uncertain. In the remaining 7 western States (California, Kansas, Nebraska, North Dakota, South Dakota, Texas, and Washington) the riparian and appropriation doctrines are recognized concurrently, but the limitations upon the riparian right vary considerably from State to State.

Underground sources.—Ground waters commonly are considered by the courts as falling into two classes: (1) water in definite underground streams, and (2) percolating water, which comprises all water in the ground other than that flowing in defined subterranean channels.

Definite underground streams.—Water in definite underground channels or streams is subject to the same rules of law as water in surface watercourses. Hence in each western State the appropriation doctrine applies equally to definite watercourses whether upon or under the surface, and the riparian doctrine in a given State applies to subterranean streams to whatever extent it is applicable to surface streams.

Percolating water.—Percolating waters have been subjected to appropriation by the statutes of some States, as noted in the ensuing discussion of the separate State water-right doctrines. In the other western States percolating waters are considered to belong to the owner of the land in which they are found, subject in some States to an unlimited right of use by the owner of overlying land, and in other States to some measure of reasonableness in the use of the water.

Summaries of State Water-Right Doctrines

Arizona

Surface sources.—The doctrine of appropriation governs rights to the use of water in watercourses, to the exclusion of the riparian doctrine. The Territorial legislature in 1887 repudiated the common-law doctrine of riparian water rights, and the State constitution contains a similar provision (art. XVII, sec. 1). The courts, furthermore, have held specifically that the riparian doctrine has been repudiated (Clough v. Wing, 2 Ariz. 371, 17 Pac. 453 (1888); Pima Farms Co. v. Proctor, 30 Ariz. 96, 245 Pac. 369 (1926)).

The water code provides that the water of all sources, flowing in streams, canyons, ravines, or other natural channels, or in definite underground channels, whether perennial

¹ Wells A. Hutchins, Senior Irrigation Economist, Division of Irrigation, Soil Conservation Service, U. S. Department of Agriculture.

or intermittent, flood, waste, or surplus water, and of lakes, ponds, and springs on the surface, belongs to the public and is subject to appropriation. An application to appropriate water must be made to the State Water Commissioner, whose approval constitutes a permit, and on completion of the appropriation the permittee receives a certificate. Determinations of water rights may be made by the State Water Commissioner, and filed in court as the basis of a civil action, or if an action to adjudicate water rights has been brought by private parties, the court may transfer the action to the commissioner for similar determination. Control over the distribution of water, excepting that reserved to water commissioners appointed by courts under existing decrees, is vested in an organization headed by the State Water Commissioner; the commissioner being authorized to create water districts and appoint water superintendents when necessary.

Underground sources.—Water flowing in definite underground channels is subject to appropriation under the water code. However, the existence of a subterranean stream must be proved by clear and convincing evidence, for ground water is presumed to be percolating (Maricopa County Municipal Water Conservation Dist. No. 1 v. Southwest Cotton Co., 39 Ariz. 65, 4 Pac. (2d) 369 (1931)). Percolating water is not subject to appropriation, but belongs to the owner of the land in which it is found (Howard v. Perrin, 8 Ariz. 347, 76 Pac. 460 (1904); Campbell v. Willard, 45 Ariz. 221, 42 Pac. (2d) 403 (1935)).

California

Surface sources.—The appropriation and riparian doctrines are in effect concurrently in California. The appropriation doctrine, as it is now recognized throughout the West originated in this State in the customs of miners on the public domain, and was later extended to irrigation and other uses.

Under the present statute waters flowing in any river, stream, canyon, ravine, or other natural channel, excepting waters needed for use upon riparian lands or otherwise appropriated, are public waters and subject to appropriation. The statute also applies to return flow that has reentered a stream, lake, or other body of water, and to water in subterranean streams flowing through known and definite channels. The statutory procedure involves an application to the State Division of Water Resources, a permit therefrom, and a license from the division upon completion of the appropriation. The division, upon the petition of one or more claimants, may make a determination of both appropriative and riparian rights upon a stream system, which is filed in court, and is heard in the form of a civil action. Any suit for the determination of water rights may be referred, in the discretion of the court, to the division as referee, and the division may accept a reference from a Federal court. The division may create water-master districts and appoint watermasters for the distribution of water.

The riparian doctrine is of outstanding importance in California water law. It was considered fully in an early case (Lux v. Haggin, 69 Calif. 255, 10 Pac. 674 (1886)) and has been reaffirmed in many subsequent decisions. A constitutional amendment in 1928 (art. XIV, sec. 3), which limited riparian and other water rights to reasonable beneficial use under reasonable methods of diversion, has been upheld by the supreme court (Peabody v. Vallejo, 2 Calif. (2d) 351, 40 Pac. (2d) 486 (1935)). The right of a riparian owner to make use of water under such limitation is safeguarded by the amendment, and the excess above his reasonable needs is public water subject to appropriation.

Underground sources.—Water in definite underground streams is subject to appropriation under the present statute. It is likewise subject to riparian rights (Verdugo Canyon Water Co. v. Verdugo, 152 Calif. 655, 93 Pac. 1021 (1908)).

Percolating water is subject to the reasonable use of owners of overlying land under the rule of correlative rights (Katz v. Walkinshaw, 141 Calif. 116, 70 Pac. 663 (1902), 74 Pac. 766 (1903)). Each landowner is entitled, in time of shortage, to a reasonable proportion of the common supply of water that underlies a group of land ownerships. If there is an excess in the common supply, above the reasonable requirements

of overlying lands, such excess may be appropriated for distant use. (Burr v. MacLay Rancho Water Co., 154 Calif. 428, 98 Pac. 260 (1908).) The statutory procedure for appropriating water, however, does not apply to percolating water; one simply takes the water and, if attacked, defends his action in court. Ground water that feeds a surface stream, that which percolates away from a stream, and the water in the stream itself, all are considered one common supply under the rule of reasonable beneficial use (Hudson v. Dailey, 156 Calif. 617, 105 Pac. 748 (1909); Lodi v. East Bay Municipal Utility Dist., 7 Calif. (2d) 316, 60 Pac. (2d) 439 (1936)).

Colorado

Surface sources.—Appropriation is the sole means of acquiring a right to use water from a watercourse in Colorado. The riparian doctrine never has been recognized in this State (Coffin v. Left Hand Ditch Co., 6 Colo. 443 (1882); Wyoming v. Colorado, 259 U. S. 419 (1922)).

The constitution provides that the unappropriated water of every natural stream is the property of the public, subject to appropriation, and that the right of appropriation shall never be denied (art. XVI, secs. 5 and 6). The statutes also provide for the appropriation of waters of natural flowing springs, and of waters that have escaped to natural channels after having been raised from mines. A further statute governs the appropriation of waste, seepage, or spring waters, giving the person on whose land the seepage or spring waters first arise the prior right if capable of use on his lands, but the supreme court has held that the landowner's prior right does not apply to such waters if they are naturally tributary to a stream (Nevius v. Smith, 86 Colo. 178, 279 Pac. 44 (1928, 1929)). Permits to appropriate water are not required in Colorado; the intending appropriator commences his construction work, and then files a claim with the State engineer, a copy of which, if in proper form, is later filed with the county clerk and recorder. The appropriation is completed by diverting the water and applying it to beneficial use, without certificate or license from the State engineer. Adjudications of water rights are made exclusively by the courts. The administration of all decreed appropriations is effected by an organization of irrigation division engineers and district water commissioners, under the supervision of the State engineer.

Underground sources.—Waters in definite underground streams are subject to the same rules as those in streams upon the surface (Medano Ditch Co. v. Adams, 29 Colo. 317, 68 Pac. 431 (1902)). These rules in Colorado are those of the appropriation doctrine.

Percolating waters tributary to a surface stream are a part of that stream and are subject to the same system of appropriative rights (Faden v. Hubbell, 93 Colo. 358, 28 Pac. (2d) 247 (1933)). No supreme court decision yet has been rendered as to the rights of use of percolating waters that are not physically tributary to some watercourse, but the reasonable inference is that such waters likewise are subject to appropriation.

Idaho

Surface sources.—The riparian doctrine is not recognized in Idaho (Jones v. McIntire, 60 Ida. 338, 91 Pac. (2d) 373 (1939)), and even in former times never was acknowledged as conflicting with the rights of appropriators for beneficial use (Schodde v. Twin Falls Land & Water Co., 224 U. S. 107 (1912)).

The constitution provides that the right to appropriate the waters of any natural stream shall never be denied, except that the State may control the use thereof for power purposes (art. XV, sec. 3). The statutes subject to appropriation all waters when flowing in their natural channels, the waters of rivers, streams, lakes, springs, and subterranean waters, and seepage, waste, and spring waters. Either of two methods of appropriation may be followed: (1) application to the State Department of Reclamation for a permit, construction of works under the terms of the permit, completion of construction that results in the issuance of a certificate, and application of

the water to beneficial use, proof of which entitles the appropriator to a license; or (2) construction of works and diversion and application of water to beneficial use, without formalities of any kind. An appropriation made according to either method is equally valid; but the priority of one who complies in all respects with the statutory procedure dates from the time of applying for the permit, while the priority of one who does not follow the statute dates from the completion of the appropriation (Bachman v. Reynolds Irr. Dist., 56 Ida. 507, 55 Pac. (2d) 1314 (1936)). A statute, which authorized State water commissioners to bring suits to adjudicate water rights was held unconstitutional (Bear Lake County v. Budge, 9 Ida. 703, 75 Pac. 614 (1904)). However, whenever suit is brought to adjudicate the waters of a stream, the court in its discretion may request the department to make a hydrographic survey. The department is charged with the responsibility of creating water districts in which adjudications have been made and of controlling the distribution of water according to priorities.

Underground sources.—Ground waters are subject to appropriation under the statute. Court decisions have held that such waters may be appropriated (Hinton v. Little, 50 Ida. 371, 296 Pac. 582 (1931)), and that the appropriation may be made, either by the statutory permit method or simply by diverting and applying the water to beneficial use (Silkey v. Tiegs, 51 Ida. 344, 5 Pac. (2d) 1049 (1931)).

Kansas

Surface sources.—The appropriation and riparian doctrines are recognized concurrently in Kansas. The riparian doctrine was well established in a case decided in 1905 (Clark v. Allaman, 71 Kans. 206, 80 Pac. 571 (1905)), and it now appears to be of paramount importance in this State (Frizell v. Bindley, 144 Kans. 84, 58 Pac. (2d) 95 (1936)).

The statutes provide that water may be appropriated, and that in the portion of the State west of the 99th meridian, all natural waters may be diverted from natural beds, basins, and channels for domestic, irrigation, and other industrial purposes, but that natural surface lakes and ponds having no outlet may be drawn off or appropriated only by the owners of the lands on which located. Appropriations of water may be made upon application to the Division of Water Resources of the State Board of Agriculture, the chief engineer of which is charged with distribution of water under rights adjudicated by the courts.

Underground sources.—A statute provides that water obtained by means of artesian wells may be appropriated. Other statutes, which relate only to the portion of the State west of the 99th meridian, provide that surface or subterranean waters may be diverted from natural beds, basins, or channels for domestic, irrigation, and other industrial purposes; but that south of township 18 and west of the 99th meridian, all waters flowing in subterranean channels and courses, or flowing or standing in subterranean sheets or lakes, shall be appurtenant to the overlying lands and devoted to the above-named uses. The few court decisions acknowledge ownership of percolating water by the owner of overlying land (Emporia v. Soden, 25 Kans. 588, 37 Am. Rep. 265 (1881); Gilmore v. Royal Salt Co., 84 Kans. 729, 115 Pac. 541 (1911)).

Montana

Surface sources.—The appropriation doctrine is exclusive in operation with respect to surface streams, inasmuch as the riparian doctrine has been repudiated by the courts (Mettler v. Ames Realty Co., 61 Mont. 152, 201 Pac. 702 (1921)). The statutes provide that appropriations may be made of water in any river, stream, ravine, coulee, spring, lake, or other natural source of supply; and of flood, seepage, and waste waters by impounding them.

There is no centralized State control in Montana over the appropriation and administration of water. An appropriation from an unadjudicated stream may be made, either by following the statute, which requires posting a notice at the point of diversion and filing a copy with the county clerk, in which case the priority dates from the time of posting notice, or by

simply diverting water and applying it to beneficial use, in which event the priority dates from completion of the appropriation. An appropriation from a stream or other source, the waters of which have been adjudicated, may be made only by filing a petition in the county court and securing a decree allowing the appropriation. Determination of water rights are made exclusively by the courts, but the State engineer, at the direction of the State Water Conservation Board, may bring action to adjudicate the waters of any stream, and may make hydrographic surveys for use in the proceedings. Waters, the rights to which have been adjudicated, may be distributed by commissioners appointed by the courts at the request of holders of at least 15 percent of the water rights affected.

Underground sources.—Water flowing in a defined underground stream is subject to the same rules of appropriation as the water of a surface stream; but percolating water belongs to the owner of the soil in which it is found (Ryan v. Quinlan, 45 Mont. 521, 124 Pac. 512 (1912)).

Nebraska

Surface sources.—The appropriation and riparian doctrines both exist in Nebraska. The constitution provides that the water of every natural stream is dedicated to the people of the State, and that the right to divert unappropriated waters from every natural stream for beneficial use shall never be denied except when the public interest demands it (art. XV, secs. 5 and 6). A statute provides, further, that water flowing in any river, stream, canyon, or ravine may be appropriated. Supplemental appropriations may be made from natural lakes or reservoirs. An application must be made to the State Department of Roads and Irrigation for a permit to appropriate water, and when the appropriation has been perfected the department sends to the county clerk a certificate for record. The department makes determinations of appropriative water rights on stream systems, which are final unless appealed to the supreme court. The department has jurisdiction over the administration of water rights, and appoints superintendents and water commissioners to distribute water.

The riparian doctrine has been established in a number of court decisions, two leading cases having been decided in 1903, but riparian rights attach only to lands that have passed to private ownership after the enactment of the irrigation act of 1889 (Crawford Co. v. Hathaway, 67 Nebr. 325, 93 N. W. 781 (1903); Meng v. Coffee, 67 Nebr. 500, 93 N. W. 713 (1903)). Furthermore, the remedies of riparian owners who have not made use of water, against appropriators from the same stream, have been substantially limited by court decisions (McCook Irr. & Water Power Co. v. Crews, 70 Nebr. 103, 115, 96 N. W. 996 (1903), 102 N. W. 249 (1905); Cline v. Stock, 71 Nebr. 70, 79, 98 N. W. 454 (1904), 102 N. W. 265 (1905)).

Underground sources.—Subterranean waters are subject to reasonable use upon the overlying land, and cannot be extracted in quantities that result in injury to owners of other overlying lands (Olson v. Wahoo, 124 Nebr. 802, 248 N. W. 304 (1933)).

Nevada

Surface sources.—The appropriation doctrine now is the sole legal system under which rights to the use of surface streams may be acquired. The riparian doctrine was recognized in some very early cases and certain riparian rights became established (Vansickle v. Haines, 7 Nev. 249 (1872)). However, the riparian doctrine was repudiated in 1885, and has not since been recognized (Jones v. Adams, 19 Nev. 78, 6 Pac. 442 (1885); In re Humboldt River, 49 Nev. 357, 246 Pac. 692 (1926)).

The statutes provide that the water of all sources of supply, whether above or beneath the surface of the ground, belongs to the public, and, subject to existing rights, may be appropriated. An application for a permit to appropriate water must be made to the State engineer, and, upon completion of the appropriation, a certificate is issued. The State engineer may determine the rights upon a stream, upon petition of one or more water users, and file his determination in court in the form of a complaint in a civil action. In any suit brought by private parties for the determination of water rights, the

court is required by statute to direct the State engineer to furnish a hydrographic survey, and in its discretion the court may transfer the suit to the State engineer for a statutory determination. The State engineer has the duty of distributing water and of creating water districts and appointing water commissioners for adjudicated streams.

Underground sources.—All ground waters are subject to appropriation, except for domestic purposes where the draught does not exceed 2 gallons per minute and where the water is not artesian. Application for a permit must be made to the State engineer, as in case of surface streams. The State engineer may designate ground-water administrative basins upon petition of at least 10 percent of the owners of wells having appropriative rights, and with his approval artesian-wells supervisors and assistants may be appointed. The State engineer on his own motion, or upon petition of water users, may hold hearings to determine the adequacy of the water supply within an area or subarea, and is required to order withdrawals restricted during a period of shortage to conform to priority rights.

New Mexico

Surface sources.—Rights to the use of waters of surface streams in New Mexico are governed solely by the appropriation doctrine. The riparian doctrine never has been recognized in this State (Snow v. Abalos, 18 N. Mex. 681, 140 Pac. 1044 (1914)).

The constitution declares that the unappropriated water of every natural stream, perennial or torrential, belongs to the public and is subject to appropriation (art. XVI, sec. 2). According to statute, seepage water from constructed works may be appropriated, the owner of the works having the first right, if exercised within one year. Application must be made to the State engineer for a permit to appropriate water; upon completion of the works a certificate of construction is issued, followed upon application of the water to beneficial use by a license to appropriate water. The appropriation statute does not apply to uses of water for watering livestock. Determinations of rights may be made in suits brought by the attorney general at the request of the State engineer, upon completing of hydrographic surveys. In suits brought by private parties the attorney general is required to intervene if the State engineer so advises, and in any adjudication suit the court is required to direct the State engineer to furnish a hydrographic survey. Administration of rights is entrusted to the State engineer, who creates districts and subdistricts, and may appoint a watermaster and assistants upon request of a majority of the users in a district.

Underground sources.—The waters of underground streams, channels, artesian basins, reservoirs, or lakes, having reasonably ascertainable boundaries, are declared by statute to be public waters subject to appropriation. An application for a permit to appropriate such water for irrigation or industrial purposes must be made to the State engineer, and claimants of vested rights may file declarations of their rights with that official. The State engineer formulates rules and regulations for administering the statute; and in certain instances he has concurrent authority with artesian conservancy districts in regulating artesian wells within such districts.

North Dakota

Surface sources.—The appropriation and riparian doctrines both are in effect in this State. A statute provides that all waters from all sources of supply belong to the public and are subject to appropriation. An earlier statute, still in effect, vests in the owner of land the ownership of water upon or under his land if it does not form a definite stream, and gives him the right to use a definite stream so long as it remains on his land, but forbids his preventing its natural flow. Seepage water from constructed works may be appropriated. An application for a permit to appropriate water must be made to the State engineer, who may grant water rights subject to the approval of the State Water Conservation Commission. A certificate of construction is issued upon completion of works, and a license to appropriate upon application of

water to beneficial use. The State engineer is required to make hydrographic surveys as the basis for suits brought by the attorney general to determine water rights. The attorney general is required to intervene in any adjudication suit upon advice of the State engineer. The court, in any adjudication suit, is to direct the State engineer to furnish a hydrographic survey. The State is divided by statute into water divisions, with provision for appointment of officials to distribute water under the supervision of the State engineer.

There has been very little litigation over water rights in North Dakota. Riparian rights, however, were recognized by the United States Supreme Court in a Territorial case (Sturr v. Beck, 133 U. S. 541 (1890)), and the common-law riparian doctrine appears to be well established (Bigelow v. Draper, 6 N. Dak. 152, 69 N. W. 570 (1896); McDonough v. Russell-Miller Milling Co., 38 N. Dak. 465, 165 N. W. 504 (1917)).

Underground sources.—A statute provides that the owner of land owns water standing thereon, or flowing over or under the surface, but not forming a definite stream, and that he may use a definite surface or subterranean stream while it remains within his boundaries, but may not prevent its natural flow.

Oklahoma

Surface sources.—The appropriation and riparian doctrines presumably are concurrent in Oklahoma. However, while there have been several court decisions concerning the rights of riparian owners, the controversies have been mainly over the pollution of streams or damage to land caused by raising water levels, and none have involved the use of water for irrigation. Hence, the status of the riparian doctrine in relation to the claims of appropriators of water has not been determined.

A statute provides that the owner of land owns water standing on it or flowing over or under the surface in other than a definite stream; that he may use a definite surface or underground stream while on his land, but may not prevent its natural flow.

Water may be appropriated by making first an application to the Oklahoma Planning and Resources Board for a permit. The supreme court has held that a hydrographic survey and adjudication are conditions precedent to the granting of a valid permit to appropriate water; pending this determination, an application for a permit may be accepted by the board to fix priority (Gay v. Hicks, 33 Okla. 675, 124 Pac. 1077 (1912); Owens v. Snider, 52 Okla. 772, 153 Pac. 933 (1915)). A certificate of completion of construction is issued when the works are completed, and a license to appropriate water when it has been applied to beneficial use. Seepage from constructed works may similarly be appropriated. Hydrographic surveys of stream systems form the basis of suits brought by the attorney general for determination of rights, and the attorney general is required by statute to intervene in a suit, if advised by the board that the public interest so requires. Furthermore, the court in an adjudication suit is required to direct the board to furnish a hydrographic survey. The board is charged with supervision over the apportionment of water, and may create water districts and appoint watermasters.

Underground sources.—The statute provides that the owner of land owns water under the surface, but not forming a definite stream. However, the supreme court has held that the use of percolating water by the landowner must be reasonable, and that he may not exhaust a neighbor's ground-water supply for transport to distant lands, but that this does not mean that in actual practice there must be an apportionment of the water (Canada v. Shawnee, 179 Okla. 53, 54 Pac. (2d) 694 (1936)).

Oregon

Surface sources.—Oregon is essentially an appropriation-doctrine State. Various court decisions, principally early ones, decided riparian rights as between riparian landowners, but the water code of 1909 restricted riparian rights to beneficial use made prior to the passage of the act, or within a reasonable time thereafter. The validity of this legislation has been upheld in the courts (In re Hood River, 114 Ore. 112, 227 Pac. 1065 (1924); California-Oregon Power Co. v. Beaver Portland Cement Co., 73 Fed. (2d) 555, C.C.A. 9th (1934)). Only

appropriative rights can be adjudicated under the statutory procedure, which means that a riparian owner's claim can be so adjudicated only for a specific flow of water with a fixed date of priority, that is, on an appropriative basis (In re Deschutes River and Tributaries, 134 Ore. 623, 286 Pac. 563, 294 Pac. 1049 (1930)). The result of the legislation and court decisions has been a practical abrogation of the riparian doctrine, except as to certain vested rights principally for domestic and stock-watering purposes.

All water from all sources of water supply is declared by statute to belong to the public, and subject to existing rights, may be appropriated. However, certain streams are exempted from appropriation in order to preserve the natural flow for scenic and other purposes. Waste, spring, or seepage waters may be appropriated, subject to the prior right of use by the person on whose land the seepage or spring water first arises. However, a spring that discharges into a watercourse is subject to rights on the stream (Hildebrandt v. Montgomery, 113 Ore. 687, 234 Pac. 267 (1925)).

Applications for permits to appropriate water for irrigation and other purposes, except for power (which are governed by the hydroelectric act), are made to the State engineer, and upon perfection of the appropriation a certificate is issued. Determinations of rights are made by the State engineer, upon petition signed by one or more users of water from a stream, and are filed in court in proceedings similar to suits in equity. The court in its discretion may transfer a water-right case to the State engineer for determination, and in a suit to which the State is a party the court is required to call upon the State engineer for a hydrographic survey. The State engineer is in control of the administration of water rights through watermasters appointed for districts which he creates.

Underground sources.—In the portion of Oregon east of the summit of the Cascade Mountains, waters in underground streams, channels, artesian basins, reservoirs, or lakes, the boundaries of which may be reasonably ascertained, are declared by statute to be public waters subject to appropriation for any purpose other than for domestic and culinary use, stock, or watering of lawns and gardens not exceeding one-half acre. Permits from the State engineer are required, as in case of surface streams. Court decisions in Oregon have acknowledged the rule that percolating water belongs to the landowner (Hayes v. Adams, 109 Ore. 51, 218 Pac. 933 (1923)), so that this rule of ownership prevails in western Oregon, but has been modified by statute in the eastern part of the State.

South Dakota

Surface sources.—The appropriation and riparian doctrines both are recognized in South Dakota. The riparian doctrine was recognized in the Territory of Dakota by the United States Supreme Court (Sturr v. Beck, 133 U. S. 541 (1890)), as well as in a number of decisions of the State Supreme Court (Platt v. Rapid City, 291 N. W. 600 (1940)), and is of major importance in South Dakota water law.

The code provides that, subject to the provisions relating to artesian wells and water, the owner of land owns the water over or under the surface, other than that flowing in a definite stream, and may use a definite surface or underground stream so long as it remains there, but may not prevent its natural flow. The supreme court has held that under this statute, water, which does not constitute a "definite stream," even though it flows for several weeks in the spring in a long channel, belongs to the landowner (Benson v. Cook, 47 S. Dak. 611, 201 N. W. 526 (1924)), and is not governed either by the appropriation or riparian doctrine (Terry v. Heppner, 59 S. Dak. 317, 239 N. W. 759 (1931)). The code also states that, subject to the foregoing statutory provision, and subject to vested private rights, all waters from every source of supply belong to the public and, except navigable waters, are open to appropriation. Seepage from constructed works may be appropriated. An appropriation is initiated by applying to the State engineer for a permit. The permittee receives a certificate of construction upon completion of works, and upon applying the water to beneficial use, a license to appropriate the water.

Under the dry-draw law, a right to the use of water from a ravine or watercourse not having a flow of at least 20 miner's inches during the greater part of the year, may be initiated by filing a location certificate with the register of deeds, posting a notice at the point of diversion, and mailing a copy to the State engineer. The claimant may obtain a certificate from the State engineer, but is not under his jurisdiction.

In an action to adjudicate water rights, the court is directed to request the State engineer to furnish a hydrographic survey, no part of the costs of the State or of the survey to be charged against private parties without their express consent. A previous provision, under which such costs were charged against private parties, was held unconstitutional (St. Germain Irrigating Ditch Co. v. Hawthorne Ditch Co., 32 S. Dak. 260, 143 N. W. 124 (1913)).

The attorney general may bring suit for the determination of rights. The State engineer is given control over all waters in definite streams, so far as they relate to irrigation or other water rights, and upon request of 5 or more holders of riparian rights in a definite stream, he is required to apportion the water. The State engineer may appoint a water commissioner for the distribution of water from any source, after consultation with the water users, to act under his direction.

Underground sources.—The ownership of ground water not in a definite stream—that is, percolating water—is vested by statute in the landowner. The supreme court has upheld the principle as stated in this statute (Madison v. Rapid City, 61 S. Dak. 83, 246 N. W. 283 (1932)). Defined or known underground streams, however, are governed by the laws that apply to surface streams (Deadwood Central R. R. v. Barker, 14 S. Dak. 558, 86 N. W. 619 (1901)).

Texas

Surface sources.—Texas recognizes both the appropriation and riparian doctrines. The appropriation statute declares the waters of the ordinary flow and underflow and tides of every flowing river or natural stream, of all lakes, bays, or arms of the Gulf of Mexico, and the storm, flood, or rain waters of every river or natural stream, canyon, ravine, depression, or watershed, to be the property of the State and subject to appropriation. An application for a permit to appropriate water must be made to the State Board of Water Engineers, and use of water for 3 years under the terms of a permit gives the appropriator a title by limitation against all other claimants to water from the same source of supply. (This limitation, however, is not operative as against the rights of riparian landowners: Freeland v. Peltier, 44 S. W. (2d) 404 (Tex. Civ. App. 1931).) Adjudications of rights are made exclusively in the courts; a statute authorizing determinations by the Board of Water Engineers having been held unconstitutional (Board of Water Engineers v. McKnight, 111 Tex. 82, 229 S.W. 301 (1921)). As a further result of this decision, the statutory provisions relating to the distribution of water under the supervision of the Board, according to rights as determined by the Board, have been repealed.

Lands that were granted prior to the passage of the irrigation act of 1889 have riparian rights, but such rights attach only to the ordinary flow and underflow of streams (Motl v. Boyd, 116 Tex. 82, 286 S. W. 458 (1926)). Waters not needed to satisfy the reasonable requirements of lands having these preexisting riparian rights, as well as storm and flood waters, may be appropriated.

Underground sources.—The underflow of streams is subject to appropriation, according to the statute; and it is also riparian water (Motl v. Boyd, *supra*). Percolating waters are the property of the owner of the land in which they are found (Texas Co. v. Burkett, 117 Tex. 16, 296 S. W. 273 (1927)).

Utah

Surface sources.—The appropriation doctrine governs rights to the use of water in Utah. Riparian rights never have been recognized (Stowell v. Johnson, 7 Utah 215, 26 Pac. 290 (1891); Whitmore v. Salt Lake City, 89 Utah 387, 57 Pac. (2d) 726 (1936)). The statutes provide that all waters, whether above or under the ground, are the property of the public, subject

to existing rights of use; and that water may be appropriated only by complying with the statutory procedure, under which an application for an appropriation must be made to the State engineer and under which a certificate is issued upon completion of the appropriation. The State engineer may initiate suits to determine water rights, and, upon the filing of any adjudication suit, the State engineer is notified by the clerk of the court, and is required to make a hydrographic survey and a proposed determination, which is filed in court as the basis of hearings and final adjudication. The State engineer has general administrative supervision over the waters of the State, and may appoint water commissioners for any river system or water source, after consultation with the water users.

Underground sources.—All ground waters are subject to appropriation under the statute as amended in 1935. Even prior to this amendment, the supreme court had applied the appropriation doctrine to the waters of artesian basins (*Wrathall v. Johnson*, 86 Utah 50, 40 Pac. (2d) 755 (1935); *Justesen v. Olsen*, 86 Utah 158, 40 Pac. (2d) 802 (1935)). The procedure for acquiring appropriative rights out of surface streams applies to ground waters as well. Existing claimants to the use of ground waters are required to file notice of their claims with the State engineer. The State engineer may define ground-water areas, and at any time on his own motion, or on petition of not less than one-third of the ground-water users in such an area, he may hold hearings to determine whether the supply is adequate for existing claims, and may apportion the supply if found inadequate. Water commissioners may be appointed for such areas.

Washington

Surface sources.—Both the appropriation and the riparian doctrines are in force in Washington. The water code declares that subject to existing rights, all waters belong to the public, and that rights may be acquired only by appropriation in the manner provided by statute; existing riparian or appropriative rights are not to be affected. An appropriation is initiated by applying to the State Supervisor of Hydraulics for a permit, and upon completion of the appropriation the claimant is entitled to a certificate. The supervisor of hydraulics may take the first step in determining rights, when in his judgment it is necessary, by preparing a statement and plan or map of the locality, and filing the same in court, and is required to do so upon petition of one or more claimants of water rights. In such suit the court refers the proceedings to the supervisor for the taking of testimony as referee, on completion of which a report is filed for further action of the court. The supervisor is in charge of the administration of water rights, in which connection he may designate water districts and appoint watermasters and stream patrolmen, when necessary, upon application of interested parties.

The riparian doctrine is important in the water law, but is of secondary importance in the irrigation economy of the

State. Riparian rights do not attach to navigable waters (*State ex rel. Ham, Yearsley and Ryrie v. Superior Court*, 70 Wash. 442, 126 Pac. 945 (1912)), and the waters of nonnavigable streams to which the riparian doctrine applies are those that can be beneficially used on or in connection with riparian land, either directly or prospectively within a reasonable time, the excess being subject to appropriation (*Brown v. Chase*, 125 Wash. 542, 217 Pac. 23 (1923)). To secure protection, a riparian owner must show that either at present, or in the near future, he will make beneficial use of the water (*State v. American Fruit Growers*, 135 Wash. 156, 237 Pac. 498 (1925)).

Underground sources.—The waters of a defined underground stream are subject to the rules that apply to surface streams (*Meyer v. Tacoma Light & Water Co.*, 8 Wash. 144, 35 Pac. 601 (1894)). Percolating waters may be used by the owner of overlying land to a reasonable extent, and in a manner consistent with the reasonable use of his land (*Patrick v. Smith*, 75 Wash. 407, 134 Pac. 1076 (1913); *Evans v. Seattle*, 182 Wash. 450, 47 Pac. (2d) 984 (1935)).

Wyoming

Surface sources.—Rights to the use of surface streams in Wyoming are governed solely by the appropriation doctrine. The riparian doctrine was repudiated in a fairly early case as inapplicable to conditions within the State (*Moyer v. Preston*, 6 Wyo. 308, 44 Pac. 845 (1896)), and has never been acknowledged (*Wyoming v. Colorado*, 259 U. S. 419 (1922)). The constitution declares that the waters of all natural streams, springs, lakes, or other collections of still water are the property of the State, subject to prior appropriation, and that no appropriation shall be denied, except when such denial is demanded by the public interests (art. VIII, secs. 1 and 3). The constitution also provides for a board of control, composed of the State engineer as president, and the superintendents of the 4 water divisions, and vests the board with supervision of the waters of the State (art. VIII, secs. 2, 4 and 5).

To appropriate water, application must be made to the State engineer for a permit. When an appropriation has been perfected and the right has been adjudicated by the board of control, a certificate of appropriation is issued by the board. Adjudications of rights of streams are made by the board of control, in each case after the State engineer has made a hydraulic survey and the superintendent of the water division has taken testimony. A determination or adjudication so made is final unless appealed to the courts. Distribution of water according to priorities is made by the organization of water superintendents and district water commissioners, under the general direction of the State engineer.

Underground sources.—Percolating waters developed artificially belong to the owner of the land upon which they are developed (*Hunt v. Laramie*, 26 Wyo. 160, 181 Pac. 137 (1919)).

TABLE 19.—PROPORTION (PERCENT) OF TOTAL OF AREAS IRRIGATED, BY TYPE OF WATER RIGHTS, BY STATES: 1939, 1929, AND 1919

STATE	APPROPRIATION ¹			RIPARIAN			APPROPRIATION AND RIPARIAN			UNDERGROUND			APPROPRIATION AND UNDERGROUND			RIPARIAN AND UNDERGROUND			ADJUDICATED BY COURT			OTHER, MIXED, AND NOT REPORTED		
	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919	1939 ²	1929	1919
Total (17 States) ³	50.1	41.6	45.9	3.9	2.8	1.9	4.6	—	—	10.6	9.3	5.7	4.5	—	—	0.6	—	—	25.2	41.6	38.5	1.4	4.8	7.9
Arizona	25.7	22.4	69.3	—	—	—	—	—	—	21.3	16.3	8.9	49.7	—	—	—	—	—	0.9	58.2	18.2	2.4	3.1	3.6
California	24.3	38.2	50.5	8.4	7.5	5.7	15.4	—	—	29.1	30.6	20.5	9.4	—	—	2.1	—	—	9.8	16.4	23.3	1.5	7.3	20.0
Colorado	40.7	10.4	9.7	—	—	—	—	—	—	2.0	0.5	0.4	0.2	—	—	—	—	—	55.8	88.4	67.2	1.3	0.7	2.7
Idaho	40.8	43.4	48.1	—	—	—	—	—	—	0.3	0.2	0.1	3.6	—	—	—	—	—	53.5	53.2	44.4	1.8	3.1	7.4
Kansas	15.4	56.9	64.8	2.7	0.1	0.1	1.9	—	—	44.8	16.3	28.5	0.4	—	—	0.2	—	—	28.1	17.7	0.9	6.5	9.0	5.7
Montana	75.6	43.7	53.6	—	—	—	—	—	—	0.1	0.1	(*)	(*)	—	—	—	—	—	23.0	50.5	41.7	1.3	5.7	4.7
Nebraska	83.3	72.4	93.0	0.7	—	—	0.1	—	—	13.3	4.4	0.1	0.3	—	—	0.3	—	—	1.5	22.3	2.1	0.5	0.9	4.7
Nevada	77.9	53.7	65.2	(*)	(*)	(*)	—	—	—	0.7	0.5	0.2	1.5	—	—	—	—	—	16.6	33.3	28.7	3.3	12.5	5.9
New Mexico	81.3	72.6	61.5	—	—	—	—	—	—	6.4	8.5	9.7	0.2	—	—	—	—	—	10.7	17.5	17.1	1.4	1.4	11.7
North Dakota	94.5	82.7	96.2	4.0	—	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	10.2	—	1.3	7.1	3.8
Oklahoma	55.1	47.1	18.8	18.4	1.1	2.7	—	—	—	13.9	5.0	4.1	—	—	—	2.1	—	—	6.4	—	74.1	4.1	46.6	0.3
Oregon	56.7	39.6	65.7	4.5	10.3	1.5	6.6	—	—	0.7	0.4	0.3	0.8	—	—	0.3	—	—	28.9	44.4	29.8	1.5	5.3	2.7
South Dakota	75.2	71.0	89.3	6.1	5.0	1.6	4.9	—	—	1.1	0.8	0.1	—	—	—	0.3	—	—	7.0	17.4	7.6	5.4	5.8	1.4
Texas	56.5	73.7	70.9	6.3	6.0	12.4	7.2	—	—	25.7	7.7	7.6	0.2	—	—	1.0	—	—	2.5	6.2	0.5	0.6	6.4	8.6
Utah	46.3	41.8	55.7	—	—	—	—	—	—	0.8	1.5	0.6	0.2	—	—	—	—	—	52.3	49.2	42.4	0.4	7.5	1.3
Washington	81.6	68.9	80.0	8.3	5.9	3.2	1.5	—	—	2.7	3.5	3.9	(*)	—	—	0.2	—	—	4.2	15.0	10.6	1.5	6.7	2.3
Wyoming	96.7	79.2	83.6	—	—	—	—	—	—	0.2	(*)	(*)	(*)	—	—	—	—	—	2.4	17.6	13.4	0.7	3.2	3.0

¹"Appropriation" includes water rights published in the 1930 and 1920 Census reports as "Appropriation and use," "Notice filed and posted," "Permit from State," "Certificate or license from State," also includes "Riparian" rights for Montana and New Mexico in 1919.

²Water rights for supplemental enterprises not included (see State table 16 for each State in the separate State Reports).

³Water rights have not been established in Arkansas, Louisiana, or Florida.

⁴Less than one-tenth of 1 percent.

⁵Riparian rights are not recognized in Nevada, except those adjudicated by courts prior to 1885. The proportion reported as "Riparian," owing to misapprehension as to its legal status, is included with that reported as "Adjudicated by Court."

Areas and Investments of the Bureau of Reclamation

Census of Irrigation.—According to statistics of the Bureau of the Census, the total area of agricultural land served with water by the Bureau of Reclamation of the United States Department of Interior, shows an increase of about 20 percent in the 10-year period, 1930 to 1940. This increase is divided almost equally between new land furnished a full supply of irrigation water, and land furnished a part supply to supplement inadequate water received from other systems.

The gains are analyzed as follows:

ITEM	Acres	Increase since 1929 (percent)
LAND WITHIN FEDERAL RECLAMATION PROJECTS		
Area irrigated-----1939	1,824,004	22
Area works were capable of irrigating-----1940	2,348,967	20
LAND OUTSIDE FEDERAL RECLAMATION PROJECTS		
Area supplied supplemental water-----1939	1,460,470	18
Area works were capable of supplying supplemental water-----1940	1,762,721	21

Scope of operations.—The most extensive construction program undertaken by the Bureau since the enactment of the Reclamation Law in 1902 began in 1933. This program resulted from an acceleration of interest in water conservation in the West, the need for public works to provide employment, and the demand for newly irrigated land for the settlement of the increasing population of the West. Increasing drafts on underground water supplies and the prolonged droughts of the 1930-40 decade affected the water supplies of established irrigated areas, which brought demands for storage and diversion facilities to provide supplemental water. Increased recognition of the possibilities of power developments in multiple-purpose projects as a means of providing revenue to aid in repayment of irrigation costs was a major contributing factor.

Because of the magnitude of some of the projects, the full results of the program will not be fully realized for several years. The rate of progress towards completion is governed by appropriations, and since the opening of World War II also by priorities for critical materials and availability of labor. Since 1930, several major projects involving new land were completed, older undertakings were extended, and storage facilities were constructed on 11 projects for the purpose of supplementing the water supplies of land inadequately irrigated by other systems. When the construction program authorized as of January 1, 1940 is completed, the Bureau will be prepared to furnish a full supply of water to 5,115,224 acres, and supplemental water to 5,700,343 acres. In operation or planned in connection with the program on January 1, 1940 are power facilities with an ultimate capacity of 4,190,162 kilowatts.¹

Since the Census of 1930, dams were completed by the Bureau which increased the reservoir capacity on projects operated primarily for irrigation to 17,292,933 acre-feet. Dams under construction or authorized will, when completed, more than double this capacity and make a total of 39,088,000 acre-feet.

In addition, the Bureau completed the storage facilities for three major multiple-purpose projects which provide a total storage capacity of 36,189,000 acre-feet: Boulder Dam, (32,359,000 acre-feet) and Parker Dam (710,000 acre-feet) on the Colorado River in the Pacific Southwest; and Marshall Ford Dam (3,120,000 acre-feet) on the Colorado River in Texas. While these projects have a direct bearing on irrigation, their other functions predominate, and statistics relating to them are not included with data on projects dealt with in the 1940 Irrigation Census.

Projects in operation.—The Bureau of Reclamation had 40 projects in operation in 1940 in 15 States: Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Of these, 7 are interstate projects. Most of the 40 are completed, but several require substantial additions to the distribution systems before their full capacities

may be utilized. Data on the acreage, irrigation and nonirrigation investment, and estimates of the costs to be repaid by irrigators on project land, supplemental water users, and power consumers have been tabulated.²

While irrigation is the major function of the Bureau of Reclamation, most of its projects in operation or under construction have multiple purposes, adding greatly to their feasibility.

Generally speaking, projects in operation are of the following types:

1. Those which provide a full or primary water supply for land wholly within project boundaries, and have no other function except in many instances the drainage of the area irrigated.
2. Those which provide a full supply for project lands brought into cultivation and at the same time afford supplemental water for areas outside of project boundaries inadequately irrigated by other systems. Some of this type have extensive power facilities which serve commercial customers and return a substantial revenue which aids in the repayment of project costs.
3. Those which store supplemental water for the irrigation of nonproject areas threatened with retrogression to desert through shortages or failure of primary water supplies. The demand for this type of project greatly increased during the drought years of the 30's and resulted in the authorization of several large projects, many with power facilities.
4. Multiple-purpose projects such as those created by construction of Boulder, Parker, and Marshall Ford Dams.

The relationship to irrigation of the projects in the first three classifications are summarized in detail in the Census Irrigation State Reports.

Of those in the fourth class, Boulder's storage and flow regulation of the Colorado River will aid irrigation in Arizona and southern California. Through the All-American Canal system, authorized by the Boulder Canyon Project Act of 1928 and which began service with the irrigation season of 1941, an adequate water supply is promised by a route entirely within the United States to half a million irrigable acres in California in the Imperial Valley and to a large potentially irrigable area which can be served by the Coachella branch of the system on the East Mesa and in the Coachella Valley.

Power developments.—Power revenues of the Boulder Plant will advance investigations and the construction of irrigation and power projects elsewhere in the 7 States of the Colorado River Basin, through the allocation of \$25,000,000 for this purpose over a period of 50 years. Power is expected to repay in 50 years about 90 percent of the cost of Boulder Dam. Storage of water for municipal purposes in southern California, flood control, river regulation, and recreation are other major functions of the project.

Parker Dam, constructed by the Bureau as a part of the Boulder system with funds provided by the Metropolitan Water District of southern California, creates a forebay from which water is pumped into the District's aqueduct for transfer 241 miles to Los Angeles and 12 other cities of the metropolitan area of southern California. The power plant at Parker Dam, beginning operation in 1942, will also supply pumping energy for Federal projects in Arizona, and for industrial and commercial purposes.

Marshall Ford Dam in Texas is primarily for flood control and power, but will also regulate the Colorado River of Texas thus aiding downstream irrigation of rice and other lands.

Projects under construction.—In addition to the three types of irrigation and the major multiple-purpose projects in operation, the Bureau of Reclamation has 18 other projects under construction nearly all of which have several purposes that were taken into consideration when the projects were authorized as economically feasible—a prerequisite to construction. These purposes include power development, municipal

¹ See footnote (3) page LV. Also, see footnote on page LVI. ² See table A on page LVII.

water supply, flood control, navigation, river regulation, soil conservation, recreation, and wildlife protection. These projects are located in the 14 States of Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. These projects are listed in the applicable State reports under the heading "Bureau of Reclamation areas and investment."

The projects under construction are divided into two classes:

1. Those which will bring new land under irrigation (with or without power or other functions to assist in repaying the cost of construction).
2. Those which will provide supplemental water for areas inadequately irrigated (with power or other facilities included).

Both classes include projects having nonreimbursable features charged to flood control or navigation, or which may represent allocations of work by the Civilian Conservation Corps or the Work Projects Administration.

Among the major multiple-purpose projects under construction which are included in the State summaries in table B, is the Columbia River Basin development in Washington, of which Grand Coulee Dam is the major engineering feature scheduled for completion in 1941. This project is expected ultimately to bring under irrigation 1,200,000 acres of land. The Central Valley Project in California as planned will benefit 2,000,000 acres now mostly under irrigation, through substituted and supplemental water supplies and the prevention of salt water intrusion in the Sacramento-San Joaquin Delta Region. It may also bring in 50,000 or more acres of new land. The Colorado-Big Thompson Project will serve 625,000 acres of producing land now mostly irrigated, in northeastern Colorado through the diversion of 300,000 acre-feet of water annually from the Colorado River Basin through a transmountain tunnel to the South Platte River Basin on the eastern slope of the Rocky Mountains. All these projects depend on revenue from power facilities for the repayment of a substantial part of the construction costs of irrigation facilities.

Other projects under construction or authorized, in addition to the All-American Canal system in California, previously mentioned, are located in Arizona, California, Idaho, New Mexico, Oklahoma, Oregon, Utah, Washington, and Wyoming, and are discussed individually in the separate Census of Irrigation State Reports under "Bureau of Reclamation areas and investments."

Included in the projects authorized or under construction is a third or new type of development represented by six projects designed to rehabilitate dry-farm or partly irrigated areas principally in the Great Plains States which were seriously affected by drought in the 1930-40 decade. These projects authorized under Water Conservation and Utilization legislation cover relatively small acreages, and contributions of nonreimbursable labor are made by Work Projects Administration and the Civilian Conservation Corps. These contributions are designed to keep the reimbursable costs of the project chargeable against the land within the ability of water users to repay from agricultural production. The Water Conservation and Utilization projects included in table B summaries are located in the States of Montana, Nebraska, North Dakota, and South Dakota. Other projects of this type authorized from 1940 to 1942 are located in Colorado, Idaho, Utah, and Wyoming.

Investigations of future irrigation projects.—Preliminary estimates by Bureau of Reclamation engineers in 1940 indicate that projects can be developed, under current standards of economic feasibility involving multiple-purpose projects, to conserve water for the irrigation of 22,120,000 acres of land in the 17 western States, west of or bisected by the 100th meridian in addition to that irrigated in 1939. These States are Arizona, California, Colorado, Idaho, Kansas, Montana,

Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

In addition, the Reclamation engineers estimate that there are 11,700,000 acres of presently irrigated land which will require supplemental water if their agricultural production is to be sustained and the established communities dependent on them maintained.

To some extent the needs of the West for water conservation for irrigation of additional lands and supplemental water are being met by the construction program made up principally of multiple-purpose projects involving irrigation, power, and flood control. In addition, in 1940 the Bureau had under way or planned investigations of 175 additional projects in the 17 western States. Many of the investigations were basin-wide and were expected to uncover feasible individual projects.¹

Power development in Reclamation irrigation projects.—The development of hydroelectric power on irrigation projects engineered by the Bureau of Reclamation is incidental to the release of water from storage reservoirs and to the utilization of drops in the canals of distribution systems. The power thus generated in many instances is used to pump irrigation water to areas that cannot be served by gravity systems. Surplus power is sold on a wholesale basis; preference in the right to buy is given to publicly-owned nonprofit utilities.

There were 28 Reclamation power plants, including Boulder Dam, in operation in 1940. The installed capacity was 879,000 kilowatts.* By 1945, the scheduled installations were to total 3,207,662 kilowatts.

Irrigation costs on Reclamation projects.—In order to display the actual costs of Bureau of Reclamation projects which the water users or lands within Reclamation projects are expected to pay for the irrigation system, and to make the statistics comparable with those presented for non-Federal irrigation enterprises, the Bureau of Reclamation separated for inclusion in the 1940 Census of Irrigation those costs which came within the Census definition of the investment in works on operating projects on December 31, 1939 (see table A). These were generally the costs of irrigation storage and distribution facilities which were charged to the agricultural lands served or to be served. The influence of multiple-purpose features upon irrigation costs was recognized, but the costs of power facilities in most instances were eliminated as were also drainage costs which are reported in the 1940 Drainage Census. In preceding censuses the drainage costs and all the Federal and non-Federal power investments (in Arizona, as an example)² were included in the irrigation schedules on which reports of the Bureau's investments were made and no specific recognition was made of costs incurred in providing supplemental water for nonproject lands.

The investment attributed to the Bureau includes certain expenditures by irrigation districts or water-user associations on Federal projects, principally in the States of Arizona, Idaho, Oregon, Washington, and Montana. The Federal investment reported to the Census also includes construction costs which have been written off by The Congress but which continue to represent an original outlay for irrigation by the United States. The over-all investment of the Bureau, as shown by the Irrigation Census Reports, includes the construction costs of facilities which provide supplemental as well as primary water supplies.

The gross per-acre construction costs of Federal Reclamation projects are three times higher than those reported by non-Federal enterprises. This is accounted for in a large measure by the accurate records of expenditures which are maintained and the outlays for storage facilities. More than 50 percent of the irrigation storage facilities of irrigation enterprises are credited to the Bureau and all these are of a permanent type of construction, as are also most of the main canals and laterals. Construction work has been carried on

¹ In 1942 the Bureau was concentrating on a shelf of at least 50 or more irrigation and multiple-purpose projects which could be quickly launched at the conclusion of World War II to provide employment, during construction, and settlement opportunities for returning service men and emergency industrial workers.

² The capacity of power plants on additional projects and revision of capacity of others authorized by July 1942 increased the ultimate capacity planned to 4,793,262 kilowatts.

³ The investment credited to the Bureau of Reclamation in State table 7, Arizona, for 1930, includes all power costs. The 1940 investment figure reflects the elimination from the irrigation investment of certain power costs and includes additional construction by the United States since 1930 which included Bartlett Dam and substantial betterments to the Salt River Project facilities.

extensively by the Government in periods of high prices of labor and materials, while there has been relatively little non-Federal construction in recent years. Much of the non-Federal irrigation was undertaken when diversions were simple and construction costs relatively low.

A more complete financial picture of Federal Reclamation projects reported to the 1940 Irrigation Census is presented by an analysis in table A of data by States on acreage and construction costs distributed among irrigation and other purposes. To show the costs repayable by water users on project lands for primary water supplies, the estimated amounts which will be returned by other beneficiaries—contractors for supplemental water, power consumers, lessors of grazing land—are given. Charge-offs and other nonreimbursable costs are also totalled.

Thus approximately 56 percent of the over-all costs of the operating projects are repayable directly from lands receiving a primary supply of water from Bureau works. The average net irrigation costs, on a basis comparable to non-Federal irrigation enterprises, is about \$71 an acre. The average per-acre cost of supplemental water provided by the Federal systems is \$22 compared with \$18.61 for similar service by non-Federal enterprises.

On Bureau of Reclamation projects under construction the influence of multiple-purpose features on the costs to be repaid by irrigation water users is even more pronounced. The double use of stored water for irrigation and generation of power; also the use of irrigation reservoirs for flood control and aid to navigation and prevention of salt water intrusion (on the Pacific Coast) are important factors. The provision of municipal water for growing cities of the arid west is an increasing consideration in Reclamation construction.

The construction program under way in 1940 involved an ultimate outlay of \$900,000,000 (exclusive of future requirements for Boulder Dam and for similar large multiple-purpose projects in operation in 1940). Of this amount more than half will be repayable by power revenues. About \$45,000,000 allocated to flood control, navigation, and relief labor, will be nonreimbursable; and \$10,000,000 will be repayable by municipalities receiving water supplies from multiple-purpose reservoirs. The remaining 43 percent of the construction costs will be repayable by water users on the 2,540,876 acres to receive primary water and on the 3,904,574 acres to receive supplemental water. Although detailed estimates of irrigation costs on some projects under construction were not available, the average construction charge for new lands brought under irrigation was estimated to be \$95 to \$100 an acre. The average charge per acre for supplemental water was estimated at \$45 to \$50 on land these new systems will benefit.¹

Under the Boulder Canyon Project Adjustment Act of 1940, the repayment of a flood control allocation of \$25,000,000 is deferred until expiration of the 50-year period of amortization. Practically all the remainder of the Boulder Dam construction costs and all other charges will be repaid by net power revenues within 50 years. The Metropolitan Water District of southern California will pay approximately 10 percent of the costs of Boulder Dam storage water. This water when released is diverted by pumping from Lake Havasu at Parker Dam downstream on the Colorado River into the District's aqueduct to supply Los Angeles and 12 other cities of the California coastal area.

For three years, \$500,000 a year from power revenues at Boulder Dam will be available for investigations of irrigation and power projects in the Colorado River Basin comprising Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The same amount annually from the same source will be available until 1987 for investigations and the construction of approved projects in this basin. In addition the States of Arizona and Nevada share extensively in Boulder Dam reserves in lieu of State taxes.

Title to Parker Dam, which was built with non-Federal funds advanced by the Metropolitan Water District of southern California, is retained in the United States. The power plant at the dam and the transmission system are being constructed with Government funds, and the Government will own one-half the power. The cost of the power facilities will be repaid from power revenues.

Of the cost of Marshall Ford Dam the amount to be repaid from power revenues by the Colorado River Authority of Texas, which operates the dam, is to be determined by the Secretary of the Interior.

None of the costs of these dams which are not directly serving irrigation nor of projects under construction are included in the Census Reports on Bureau of Reclamation investment.

Water conservation and utilization projects, designed to rehabilitate drought-stricken areas in the Great Plains and elsewhere and provide employment in rural areas, were first authorized by the Interior Department Appropriation Act of 1940. Later authorization was contained in the Water Conservation and Utilization Act (53 Stat. 1418), which provides for cooperation between the Departments of the Interior and Agriculture in the settlement and agricultural development of projects. The costs directly appropriated from the Federal Treasury are wholly reimbursable without interest in 40 annual payments, and do not include the contribution of labor by WPA forces and CCC enrollees, which are nonreimbursable.

Financial aspects of reclamation.—Until 1933, all Bureau of Reclamation construction except Boulder Dam was financed from the Reclamation Fund set up by the Reclamation Law of 1902. This fund comprised the proceeds from the sale of public lands, oil royalties, and repayments of construction costs, supplemented by occasional loans from the Federal Treasury which have all been repaid. Interest on bonds advanced for irrigation construction was waived in the Reclamation Law of 1902 as a concession to the national interest in the development of the area west of the 100th meridian where the Federal Government retains ownership of more than half of the land area. The interest-free policy has continued with funds subsequently allocated or appropriated from the Federal Treasury for irrigation facilities for large projects, including the Grand Coulee Dam (Columbia Basin Project) in Washington and the Central Valley in California. Interest is computed on the construction investment in power facilities at the rate of 3 percent annually.

The ultimate investment in Bureau of Reclamation projects, completed and under construction on July 1, 1940, is estimated at \$1,350,000,000.¹ Of this amount about \$600,000,000 is yet to be made available. Nearly half of the total investment will be repaid by water users, more than 45 percent by revenues from power and municipal water, and about 5 percent will be charged off to flood control, navigation, and other nonreimbursable activities.

The Reclamation Project Act of 1939 fixes the interest rate at not less than 3 percent on construction costs allocable to power facilities.

Although in times of unusual agricultural distress, as in the early 1930's, The Congress has granted moratoria on repayments to the Reclamation Fund. On July 1, 1940, fully 25 percent of construction costs of projects completed and in operation had been repaid.

Since 1926 the period of repayments of construction costs without interest to the Reclamation Fund has been 40 years. The Reclamation Project Act of 1939 reaffirmed that repayment period and provided for new contracts with a more flexible method of repayment based on varying crop returns with interest on unpaid or deferred balances.

A notable development in the matter of repayment of Reclamation construction costs is the creation of the Northern Colorado Conservancy District to aid in financing the Colorado-Big Thompson Project in Colorado. This project involves the diversion of water from the western portion of the State through the 13-mile Continental Divide Tunnel to supplement the supply for a highly developed irrigated area in the eastern portion. By popular vote the District imposed an ad valorem tax on urban and rural property with its limits, to assure the repayment of approximately one-fourth of the irrigation costs of the project. The remaining three-fourths of the irrigation costs charged to the District will be repaid by water users under the Reclamation Law. The irrigation costs repayable by the District will cover about half of the entire construction costs of the project. Power revenues will repay the remaining one-half of the construction costs.

¹ Projects authorized between January 1, 1940 and June 30, 1942, increase the total acreage to be served by the Bureau when the current program is completed to 5,115,224 acres with a primary supply and 7,116,074 acres with a supplemental supply, a total of 12,231,298 acres. These additional projects and increases in cost estimates place the over-all investment, when the current program of the Bureau of Reclamation is completed, including power facilities for 4,827,162 kilowatts, at \$1,653,607,003. The power facilities include the costs of Boulder Dam, Grand Coulee Dam, and other projects which are linked with irrigation.

GENERAL DISCUSSION

LVII

TABLE A.—SUMMARY OF DATA ON BUREAU OF RECLAMATION PROJECTS¹ IN OPERATION, JANUARY 1, 1940, WITH ESTIMATES OF COSTS REPAYABLE BY PROJECT LAND AND OTHER BENEFICIARIES

STATE	PROJECT LAND (PRIMARY SUPPLY)		OUTSIDE PROJECTS (SUPPLEMENTAL WATER)		CONSTRUCTION COSTS AND OTHER ITEMS REPAYABLE TO DEC. 31, 1939 ²			COSTS NOT REPAYABLE BY PROJECT LANDS			Amount repayable by all beneficiaries	REPAYABLE BY PROJECT LANDS		
	Irrigated 1939	Works were capable of supplying 1940	Irrigated 1939	Works were capable of supplying 1940	Irrigation (primary-supplemental)	Nonirrigation (power, drainage, etc.) ³	Total	Authorized charge-offs and other nonreimbursable items ⁴	Repayable by non-project land, power, etc.	Total		Net irrigation costs ⁵	Net drainage costs	Total
	Acres	Acres	Acres	Acres	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Arizona	265,042	297,669	58,044	90,943	39,708,470	11,671,780	51,380,250	2,276,541	29,467,898	51,744,439	49,103,709	18,682,069	953,742	19,635,811
California	44,581	60,297	1,709	1,709	5,915,578	798,674	6,714,252	505,032	1,436,063	1,941,095	6,209,220	4,192,485	580,672	4,773,157
Colorado	85,137	121,746	13,074	16,336	12,928,239	1,411,577	14,339,816	2,073,165	1,644,315	3,717,480	12,266,651	9,481,970	1,140,366	10,622,336
Idaho	544,638	424,840	842,715	973,656	41,868,781	5,037,982	46,906,763	84,681	17,790,281	17,874,962	46,822,082	26,477,464	2,554,337	29,031,801
Montana	186,002	323,197	—	—	26,607,374	11,630,797	28,238,171	3,210,080	195,000	3,405,080	25,028,091	23,390,433	1,442,658	24,833,091
Nebraska	160,799	180,155	96,602	105,996	14,659,810	1,193,750	15,853,560	—	5,977,166	5,977,166	15,853,560	8,677,129	1,199,265	9,876,394
Nevada	57,471	66,788	11,874	41,210	8,838,237	1,460,121	10,298,358	4,437,820	2,867,749	7,305,569	5,860,536	1,857,460	1,135,329	2,992,789
New Mexico	98,064	115,695	—	—	7,760,844	10,334,649	18,095,493	2,879,007	5,879,445	8,758,452	15,216,486	7,001,827	2,335,214	9,337,041
North Dakota	14,131	19,928	—	—	1,393,237	176,431	1,569,668	—	131,162	1,438,506	1,262,075	176,431	1,438,506	—
Oregon	130,403	175,171	85,042	117,733	27,002,875	1,269,961	28,272,836	895,841	5,041,813	5,937,654	27,376,995	21,251,647	1,083,535	22,335,182
South Dakota	34,222	72,504	—	—	4,628,868	729,515	5,358,383	379,031	—	379,031	4,979,352	4,249,837	729,515	4,979,352
Texas	61,153	69,010	12,881	17,119	3,147,764	1,622,872	4,770,636	336,554	300,000	636,554	4,434,082	2,511,210	1,622,872	4,134,082
Utah	38,623	40,812	161,455	193,021	12,698,755	184,731	12,883,486	—	10,334,063	10,334,063	12,883,486	2,549,423	—	2,549,423
Washington	167,085	210,512	161,876	188,677	27,675,132	411,684	28,086,816	1,047,651	6,697,881	7,745,532	27,039,165	20,341,284	—	20,341,284
Wyoming	136,653	170,643	15,398	16,321	15,411,395	6,316,293	21,727,688	1,545,129	4,596,087	6,141,216	20,182,559	12,384,482	3,201,990	15,586,472
Totals	1,824,004	2,248,967	1,460,470	1,762,721	250,245,359	44,250,817	294,496,176	18,801,694	19,227,761	112,029,455	274,694,482	164,310,795	18,155,926	182,466,721
Less non-Federal expenditures	—	—	—	—	—	—	126,580,309	—	—	—	26,580,309	—	—	—
Net Federal costs	—	—	—	—	—	—	267,915,867	—	—	—	248,114,173	—	—	—

- ¹There are 40 projects mentioned under "Bureau of Reclamation Areas and Investment" in 15 State Reports.
²Other items repayable include operation and maintenance during construction, penalties, etc.
³Power plants are located in the States of Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, Utah, Washington, and Wyoming.
⁴Principally charge-offs authorized by Act of May 25, 1926.
⁵Average net irrigation costs repayable by project land estimated at \$71 an acre.
⁶Additional areas of 225,381 acres in operating projects, principally in Idaho, Montana, and Wyoming, brings total ultimate area to be served under present plans to 2,574,348 acres.
⁷Primary irrigation costs, \$211,046,133; supplemental, \$39,199,226.
⁸Total power costs estimated at \$26,102,891, including small outlays for miscellaneous purposes; drainage costs, \$18,147,926.
⁹Estimated additional investment to complete projects under present plans is \$12,780,426, bringing total completed cost of 40 operating projects to \$307,276,602.
¹⁰Estimated net power revenues in 40 years, \$50,026,981; amounts repayable by supplemental water, grazing lessors, and other beneficiaries, \$42,200,780, making a total of \$92,227,761 from these sources to be applied to over-all project costs.
¹¹Principal non-Federal outlays in Arizona for power-irrigation facilities; others for irrigation in Idaho, Nevada, Washington, and Wyoming.

TABLE B.—SUMMARY OF STATE DATA ON BUREAU OF RECLAMATION PROJECTS, UNDER CONSTRUCTION OR AUTHORIZED AND IN OPERATION, JANUARY 1, 1940

STATE	ULTIMATE AREA TO BE SERVED		Construction cost to December 31, 1939	Estimated completed cost ¹	ESTIMATED CONSTRUCTION NOT REPAYABLE BY LAND			Estimated costs repayable by land ³
	Primary supply (new land)	Supplemental water ⁴			Nonreimbursable items ²	Net power revenues	Other sources of income	
	Acres	Acres	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Projects under construction and authorized: ⁵								
Arizona	139,000	11,000	4,430,941	20,500,000	—	—	—	20,500,000
California	742,000	2,525,000	56,286,321	293,863,000	12,000,000	108,000,000	853,000	175,010,000
Colorado	36,400	1,054,074	5,984,322	76,047,000	8,600,000	29,288,000	—	38,159,000
Idaho	51,400	160,000	3,223,405	21,946,800	5,050,000	3,400,000	—	13,496,800
Montana	12,800	—	—	2,010,000	940,000	—	—	1,070,000
Nebraska	12,000	—	—	2,580,000	1,575,000	—	—	985,000
New Mexico	45,000	—	180,695	8,155,000	2,500,000	—	—	5,655,000
North Dakota	18,276	—	—	2,090,000	1,210,000	—	—	880,000
Oklahoma	70,000	—	47,364	5,600,000	2,520,000	—	1,080,000	2,000,000
Oregon	56,000	47,500	512,042	9,430,000	2,000,000	—	—	7,430,000
South Dakota	—	12,000	—	2,470,000	1,490,000	—	—	480,000
Utah	10,000	95,000	3,052,618	15,774,000	—	—	—	5,782,000
Washington	1,272,000	—	111,557,290	412,585,000	—	298,908,000	—	113,677,000
Wyoming	76,000	—	20,125,805	26,500,000	—	17,200,000	—	9,300,000
Subtotal	2,540,876	3,904,574	205,370,799	899,530,000	37,885,000	456,796,000	12,425,000	392,424,800
Major multiple-purpose projects in operation, also under construction, July 1, 1940:								
Arizona-Nevada, Boulder Dam	—	—	120,923,931	135,000,000	—	122,500,000	12,500,000	—
Arizona-California, Parker Dam (Power) ⁷	—	—	2,900,000	12,895,000	—	12,895,000	—	—
Texas, Marshall Ford Dam ⁸	—	—	13,306,179	24,991,000	—	—	24,991,000	—
Subtotal	—	—	137,130,110	172,886,000	—	135,395,000	37,491,000	—
Irrigation projects in operation (see table A, footnotes 1, 2, and 4 to 11):								
Subtotal	2,574,348	1,795,769	10294,496,176	307,276,602	19,801,694	49,945,865	—	237,529,043
GRAND TOTAL	5,115,224	5,700,343	636,997,085	1,379,692,602	57,686,694	642,136,865	49,916,000	629,953,843

- ¹Revision upward of construction costs and additional authorizations, January 1, 1940 to July 1942, increase estimates of over-all costs of entire program to \$1,653,607,003.
²Nonreimbursable items include flood control and navigation allocations, contributions of labor by WPA and CCC.
³Includes reimbursable costs to be repaid by water users for primary and supplemental supplies.
⁴In California large areas will receive a substituted water supply or will be benefited by repulsion of salt water.
⁵Includes 18 projects authorized under the Reclamation Law and 6 under water conservation and utilization legislation.
⁶Allocations are for municipal water supplies.
⁷Funds advanced by Metropolitan Water District for construction of Parker Dam estimated at \$6,600,000 not included.
⁸Includes reimbursable costs of Marshall Ford Dam from power revenues to be determined by Secretary of the Interior.
⁹Ultimate acreage planned for operating projects shown in footnote number 6 on table A.
¹⁰Includes \$26,580,309 of non-Federal funds invested in operating projects principally in Arizona.
¹¹From January 1940 and July 1942 additional projects authorized increase ultimate supplemental acreage to 7,116,074 acres, making a total of 12,231,298 acres to be served when current program (1942) is completed.

Irrigation Census by Drainage Basins

The special Irrigation Census of 1902 presented the first list of major and tributary drainage basins used for Census purposes. For the Census of 1940, the number of tributary drainage basins was greatly increased and for the first time specific boundary lines for drainage basins were determined and delineated on maps to define more clearly the drainage basins used as unit areas for the Census of Irrigation.

The boundaries shown on the maps follow natural divides between stream systems as closely as could be determined from available topographical maps and other sources. However, where valley lands of tributary streams approach similar lands of the arterial stream, it often became necessary to select more or less arbitrary locations for boundaries, although in each case the boundaries of a given basin were located, as far as possible, to include irrigation projects and areas irrigated from water originating within that basin. It is realized that in many instances, with adequate field studies, more exact and desirable boundaries could be established and some of the drainage basins listed might be replaced by more important ones. It would also add to the usefulness of Census data if the larger drainage basins or divisions thereof, used in the Census of Irrigation, could be closely harmonized with the sections of major basins used as units for the measurement of stream flow, administration of water, and for water and land conservation planning.

The summary drainage basin tables in section C of this volume do not show all individual basins mapped or for which statistics are tabulated in the State reports reprinted in section D.

The summary tables do, however, show interstate drainage basins. The drainage basins not named in these tables represent intra-state tributary drainage basins, the statistics for which are totaled in groups by States, and the groups in turn are listed in their proper positions within the major basins.

The 17 western States and Arkansas and Louisiana extend into and are a part or all of 12 major basins and arbitrary groups of basins designated as, Red River of the North (I) (Lake Winnipeg Basin, Canada); Missouri River (II); Mississippi River, exclusive of Missouri River (III); Gulf of Mexico streams, other than Mississippi River and Rio Grande (IV); Rio Grande (V); Colorado River (VI); Gulf of California (Mexico), exclusive of Colorado River (VII); Whitewater Draw (1) and Vamori Wash (2); Great Basin (VIII); Columbia River (IX); Klamath River (X); Pacific Ocean Streams, excluding Gulf of California streams and Columbia and Klamath Rivers (XI); and Sacramento-San Joaquin Delta and tributary streams (XII). These principal drainage basins are divided into secondary and minor tributary basins as shown in the drainage basin tables of the State reports, the map lists, and the following master list. The master list gives names of the drainage basins which reported irrigated lands in 1939, while the lists attached to the State and composite maps show all basins mapped regardless of irrigated acreage. The numbers in parentheses (), following each basin and State name, are index numbers of basins as delineated on the State maps. The numbers and letters shown in column 2 of the master list are for drainage basins on the composite map. Basins for the State of Florida are shown at the end of the list.

NAMES OF DRAINAGE BASINS WITH INDEX NUMBERS

(For the 17 western States and Arkansas, Louisiana, and Florida. State and composite maps, "Irrigation—by Drainage Basins—1939," available from the Superintendent of Documents, Washington, D. C.)

NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables
Lake Winnipeg Basin (Canada):		Missouri River—Continued		Missouri River—Continued	
Red River (of the North)—N. Dak. (1)-----	I	Yellowstone River—Continued		Big Sioux River—S. Dak. (8)-----	56
Souris River—N. Dak. (2)-----	1	Big Horn River—Continued		Platte River direct—Nebr. (8)-----	II-B
Missouri River Direct—Mont. (1); N. Dak.		Nowood Creek—Wyo. (19)-----	14	North Platte River direct—Colo. (6);	
(4); S. Dak. (5); Nebr. (1); Kans. (1)-----	II	Greybull River—Wyo. (15)-----	15	Wyo. (52); Nebr. (4)-----	II-Ba
Jefferson River direct—Mont. (2)-----	1	Shell Creek—Wyo. (74)-----	16	Beaver Creek—Wyo. (82)-----	1
Beaverhead River direct—Mont. (3)-----	2	Shoshone River—Sage Creek—Wyo. (11);		Encampment Creek—Colo. (83);	2
Blacktail Deer Creek—Mont. (4)-----	3	Mont. (42)-----	17	Wyo. (61)-----	2
Ruby River—Mont. (5)-----	4	Little Horn River—Wyo. (9);		Spring Creek—Wyo. (60)-----	3
Big Hole River—Mont. (8)-----	5	Mont. (43)-----	18	Pass Creek—Wyo. (56)-----	4
Boulder River—Mont. (7)-----	6	Rosebud Creek—Mont. (44)-----	19	Medicine Bow River direct—Wyo. (51)-----	5
Madison River—Mont. (8); Wyo. (77)-----	7	Tongue River direct—Wyo. (6);		Rock Creek—Wyo. (71)-----	6
Gallatin River—Mont. (9); Wyo. (76)-----	8	Mont. (45)-----	20	Little Medicine Bow River direct—	
Smith River—Mont. (10)-----	9	Goose Creek—Wyo. (8)-----	21	Wyo. (75)-----	7
San River—Mont. (11)-----	10	Powder River direct—Wyo. (5);		Sheep Creek—Wyo. (72)-----	8
Belt River—Mont. (12)-----	11	Mont. (46)-----	22	Muddy Creek—Wyo. (68)-----	9
Marias River direct—Mont. (13)-----	12	South Fork—Wyo. (24)-----	23	Great Divide—Wyo. (50)-----	10
Teton River—Mont. (14)-----	13	Middle Fork—Wyo. (22)-----	24	Sweetwater River—Wyo. (58)-----	11
Arrow River—Mont. (15)-----	14	Crazy Woman Creek—Wyo. (20)-----	25	Boxelder Creek—Wyo. (57)-----	12
Judith River—Mont. (16)-----	15	Clear Creek—Wyo. (7)-----	26	La Poudre Creek—Wyo. (56)-----	13
Dog Creek—Mont. (17)-----	16	Little Powder River—Wyo. (4);		La Bonte Creek—Wyo. (55)-----	14
Musselshell River direct—Mont. (18)-----	17	Mont. (47)-----	27	Laramie River direct—Colo. (5);	
Boxelder and Flat Willow Creeks—		O'Fallon Creek—Mont. (48)-----	28	Wyo. (64)-----	15
Mont. (19)-----	18	Little Missouri River direct—Wyo. (5);		Little Laramie River—Wyo. (63)-----	16
Dry Creek—Mont. (20)-----	19	Mont. (49); South Dak. (7); N. Dak. (7)-----	II-Con.—51	Sybil Creek—Wyo. (55)-----	17
Milk River direct—Mont. (21)-----	20	Boxelder Creek—Mont. (50); S. Dak.;		North Laramie River—Wyo. (52)-----	18
Sandy Creek—Mont. (22)-----	21	N. Dak.-----	52	Chugwater Creek—Wyo. (54)-----	19
Clear Creek—Mont. (23)-----	22	Little Beaver Creek—Mont. (51);		Rawhide Creek—Wyo. (54)-----	20
Lodge and Battle Creeks—Mont. (24)-----	23	N. Dak. (13)-----	33	Horse Creek—Wyo. (53)-----	21
Snake Creek—Mont. (25)-----	24	Beaver Creek—Mont. (52); N. Dak. (9)-----	34	Blue Creek—Nebr. (5)-----	22
Frenchman Creek—Mont. (26)-----	25	Knife River—N. Dak. (6)-----	35	South Platte River direct—Colo. (52);	
Beaver Creek—Mont. (27)-----	26	Heart River—N. Dak. (10)-----	36	Nebr. (9)-----	II-Bb
Rock Creek—Mont. (28)-----	27	Cannonball River—S. Dak.; N. Dak. (11)-----	37	Plum Creek—Colo. (31)-----	1
Redwater Creek—Mont. (29)-----	28	Grand River—N. Dak. (12); S. Dak. (6)-----	38	Bear Creek—Colo. (29)-----	2
Poplar River—Mont. (30)-----	29	Moreau River—S. Dak. (8)-----	39	Cherry Creek—Colo. (19)-----	3
Big Muddy Creek—N. Dak.; Mont. (31)-----	30	Chayenne River direct—S. Dak. (10)-----	40	Clear Creek—Colo. (28)-----	4
Yellowstone River direct—Wyo. (16);		Belle Fourche River direct—Wyo. (2);		St. Vrain Creek direct—Colo. (15)-----	5
Mont. (33); N. Dak. (8)-----	II-A	Mont. (53); S. Dak. (12)-----	41	Boulder Creek—Colo. (20)-----	6
Shields River—Mont. (34)-----	1	Redwater Creek—Wyo. (1); S. Dak. (15)-----	42	Thompson River—Colo. (14)-----	7
Boulder River—Mont. (35)-----	2	South Fork Chayenne River direct—		Catche la Poudre River—Wyo. (70);	
Stillwater River direct—Mont. (36)-----	3	Wyo. (21); Nebr. (12); S. Dak. (26)-----	43	Colo. (4)-----	8
Fishtail and West Rosebud Creeks		Battle and Spring Creeks—S. Dak. (24)	44	Crow Creek—Wyo. (66); Colo. (2)-----	9
direct—Mont. (37)-----	4	Rapid and Box Elder Creeks—S. Dak.		Bigjon Creek group—Colo. (16)-----	10
East Rosebud Creek—Mont. (38)-----	5	(15)-----	45	Pawnee Creek—Colo. (72)-----	11
Clarks Fork direct—Wyo. (12); Mont. (39)	6	Elk Creek—S. Dak. (14)-----	46	Horsetail Creek—Colo. (1)-----	12
Red Lodge and Rock Creeks—Mont. (40)	7	Cherry Creek—S. Dak. (11)-----	47	Lodgepole Creek—Wyo. (65); Nebr. (10)-----	13
Big Horn River direct—Wyo. (10);		Bad River—S. Dak. (16)-----	48		II-B—Con.
Mont. (41)-----	8	White River direct—Nebr. (5);		Loup River—Nebr. (6)-----	1
Popo Agie River—Wyo. (31)-----	9	S. Dak. (22)-----	49	Elkhorn River—Nebr. (7)-----	2
Wind River—Wyo. (25)-----	10	South Fork White River—S. Dak. (20)-----	50	Kansas River direct—Kans. (7)-----	II-C
Owl Creek—Wyo. (44)-----	11	Niobrara River—Wyo. (55); S. Dak. (21);		Republican River direct—Colo. (18);	
Cottonwood Creek—Wyo. (18)-----	12	Nebr. (2)-----	51	Nebr. (11); Kans. (8)-----	1
Gooseberry Creek—Wyo. (17)-----	13	Keya Paha River—S. Dak. (19);		Arkaree River—Colo. (17); Kans.;	
		Nebr. (15)-----	52	Nebr. (17)-----	2
		James River—N. Dak. (5); S. Dak. (4)-----	54	Frenchman Creek—Colo. (82); Nebr. (16)-----	3

GENERAL DISCUSSION

LXIII

NAMES OF DRAINAGE BASINS WITH INDEX NUMBERS—Continued

(For the 17 western States and Arkansas, Louisiana, and Florida. State and composite maps, "Irrigation—by Drainage Basins—1939," available from the Superintendent of Documents, Washington, D. C.)

NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables
Missouri River—Continued		Rio Grande—Continued		Colorado River—Continued	
Kansas River—Continued		Upper Rio Grande—Continued		Upper Colorado River—Continued	
Smoky Hill River direct—Colo. (71);		Alamosa and La Jara Creeks—Colo. (65)—	1	San Juan River—Continued	
Kans. (5)	4	Trinchera Creek—Colo. (55)	2	Los Pinos River—Colo. (63);	2
Saline River—Kans. (8)	5	Conchos River direct—Colo. (67)	3	N. Mex. (36)	3
Solomon River—Kans. (4)	6	San Antonio River—N. Mex. (15)	4	Animas River—Colo. (62); N. Mex. (37)	4
White Woman Creek—Colo. (73);	7	Costilla Creek—Colo. (68);	5	La Plata River—Colo. (61);	5
Kans. (12)	8	N. Mex. (16)	6	N. Mex. (38)	6
Big Blue River—Nebr. (15); Kans. (2)	II-D	Latir Creek and Red River—N. Mex. (17)	7	Chaco River—N. Mex. (39)	7
Osage River—Kans. (9)	III	Rio Hondo—N. Mex. (18)	8	Mancos River—Colo. (60); N. Mex.	8
Mississippi River direct, exclusive of		Rio Pueblo de Taos—N. Mex. (19)	9	McElmo Creek—Colo. (59); Utah (36)	9
Missouri River—Ark. (11); La. (1)	III	Embudo River—N. Mex. (20)	10	Montezuma Creek—Colo. (74); Utah (37)	10
St. Francis River direct—Ark. (1)	1	Rio Chama direct—Colo. (75);	11	Cottonwood Wash—Utah (38)	11
L'Anguille River—Ark. (10)	2	N. Mex. (21)	12	Chinle Creek—N. Mex. (40); Ariz. (3);	12
White River direct—Ark. (13)	3	Calliente River—N. Mex. (22)	13	Utah (39)	13
Black River—Ark. (3)	4	Santa Cruz River—N. Mex. (23)	14	Paria River—Utah (40); Ariz. (4)	VI-A-Con.
Village River—Ark. (24)	5	Tesuque Creek—N. Mex. (24)	15	Lower Colorado River direct (exclusive of	25
Cache River direct—Ark. (2)	6	Jemez Creek—N. Mex. (25)	16	Imperial Valley)—Ariz. (1); Nev. (26);	
Bayou de Vue—Ark. (9)	7	Rio Puerco direct—N. Mex. (26)	17	Calif. (101)	VI-B
Big Creek—Ark. (23)	8	San Jose River—N. Mex. (27)	18	Little Colorado River direct—Ariz. (5);	
Arkansas River direct—Colo. (53);	9	Alamosa River—N. Mex. (28)	19	N. Mex. (41)	VI-Ba
Kans. (10); Okla. (3); Ark. (7)	III-A	San Luis Creek direct—Colo. (45)	20	Nutrisio Creek—Ariz. (6)	1
Texas Creek—Colo. (77)	1	Saguache Creek—Colo. (44)	21	Concho Creek—N. Mex.; Ariz. (7)	2
Grape Creek—Colo. (46)	2	San Luis Lake—Colo. (66)	22	Zuni River—N. Mex. (42); Ariz. (8)	3
Turkey Creek—Colo. (47)	3	San Augustine—N. Mex. (48)	23	Silver Creek—Ariz. (9)	4
Fountain Creek—Colo. (48)	4	Estancia Valley—N. Mex. (49)	24	Puerco River—N. Mex. (45); Ariz. (10)	5
St. Charles River—Colo. (49)	5	Tularosa Valley—N. Mex. (50)	25	Salt Lake and Rito Creek—N. Mex. (47)	6
Huerfano River direct—Colo. (54)	6	Rio Tularosa—N. Mex. (51)	VI		
Cucharas River—Colo. (55)	7	Fresnal River—N. Mex. (52)	VI	Kanab Creek—Utah (41); Ariz. (11)	VI-B-Con.
Apishapa River—Colo. (52)	8	Sacramento River and Salt Lakes—N. Mex.	25	Virgin River direct—Utah (42);	1
Timpan Creek—Colo. (51)	9	(53); Tex. (21)	26	Ariz. (12); Nev. (27)	2
Purgatoire River—N. Mex. (1); Colo. (69)	10	Mimbres Valley—N. Mex. (54)	VI-B	Ash Creek—Utah (43)	3
Big Sandy Creek—Colo. (30)	11	Lower Rio Grande direct—Tex. (1)	1	Santa Clara River—Utah (44)	4
Two Butte and Bear Creeks—Colo. (50);	12	Pecos River direct—N. Mex. (29);	2	Muddy River direct—Nev. (28)	5
Kans. (13)	13	Tex. (2)	3	Meadow Valley Wash—Nev. (29)	6
Pawnee River—Kans. (11)	14	Gallinas River—N. Mex. (30)	4	Las Vegas Valley—Nev. (30)	7
Salt Fork Arkansas River—Kans. (16);	15	Rio Hondo—N. Mex. (31)	5	Williams River—Ariz. (15)	8
Okla. (4)	16	Rio Penasco—N. Mex. (32)	6	White River—Nev. (42)	9
Cimarron River—N. Mex. (2); Okla. (5);	17		VI	Pahrnagat Valley—Nev. (43)	10
Colo. (70); Kans. (14)	18	Colorado River	VI	Red Lake—Ariz. (31)	11
Verdigris River—Kans. (15); Okla. (2)	19	Upper Colorado River direct—Colo. (13);	VI-A	Whitewater River—Calif. (100)	12
Neosho River—Kans. (9); Okla. (1);	20	Utah (18); Ariz.	1	Gila River	VI-Bb
Ark. (5)	21	Fraser River—Colo. (21)	2	Upper Gila River direct—N. Mex. (44);	1
Canadian River direct—N. Mex. (3);	22	Williams River—Colo. (22)	3	Ariz. (14)	2
Tex. (16); Okla. (7)	23	Muddy Creek—Colo. (12)	4	San Francisco River—N. Mex. (45);	3
Vermejo River—N. Mex. (4)	24	Blue River—Colo. (27)	5	Ariz. (15)	4
Cimarron River—N. Mex. (5)	25	Eagle River—Colo. (26)	6	Blue River—N. Mex. (46);	5
Ocate Creek—N. Mex. (6)	26	Roaring Fork—Colo. (54)	7	Ariz. (16)	6
Mora River direct—N. Mex. (7)	27	Elk Creek—Colo. (78)	8	San Simon Creek—Ariz. (17)	7
Coyote Creek—N. Mex. (8)	28	Garfield Creek—Colo. (76)	9	San Carlos River—Ariz. (18)	8
Sapello Creek—N. Mex. (9)	29	Roan Creek—Colo. (25)	10	San Pedro River—Ariz. (19)	9
Ute Creek—N. Mex. (10)	30	Plateau Creek—Colo. (35)	11	Queen Creek—Ariz. (20)	10
Carrizo and Mustang Creeks—	31	Gunnison River direct—Colo. (40)	12	Santa Cruz River direct—Ariz. (21)	11
N. Mex. (11); Tex. (17)	32	Taylor River—Colo. (42)	13	Rillito Creek—Ariz. (22)	12
North Canadian River—N. Mex. (12);	33	Slate River—Colo. (41)	14	Salt River direct—Ariz. (23)	13
Okla. (6); Tex. (18)	34	Tomichi Creek—Colo. (43)	15	Black River—Ariz. (24)	14
Red River direct—N. Mex. (13); Tex. (19);	35	Smith Fork—Colo. (38)	16	Tonto Creek—Ariz. (25)	15
Okla. (9); Ark. (19); La. (2)	36	North Fork—Colo. (39)	17	Verde River—Ariz. (26)	16
Washita River—Tex. (20); Okla. (10)	37	Uncompahgre River—Colo. (37)	18	Lower Gila River direct—Ariz. (27)	17
Black River—La. (3)	38	Salt Creek group—Colo. (24); Utah	19	Aqua Fria River—Ariz. (28)	18
Quachita River—Ark. (16); La. (4)	39	Little Dolores River—Colo. (81);	20	Hassayampa River—Ariz. (29)	19
Bartholomew Bayou—Ark. (22); La. (7)	40	Utah (19)	21	Centennial Wash—Ariz. (30)	20
Gulf of Mexico, other than Mississippi	IV	Dolores River direct—Colo. (36);	22	Animas Valley—N. Mex. (55)	21
River and Rio Grande		Utah (20)	23	Sulphur Springs—Ariz. (33)	22
Baffins Bay—Tex. (5)	1	San Miguel River—Colo. (58)	VI-Aa	Imperial Valley—Calif. (102)	VI-C
Nueces River—Tex. (4)	2	Green River direct—Wyo. (40); Utah	1		
Guadalupe River direct—Tex. (5)	3	(21); Colo. (9)	2	Gulf of California (Mexico), exclusive of,	VII
San Antonio River—Tex. (6)	4	Horse Creek—Wyo. (29)	3	Colorado River, (total)	
Colorado River direct—N. Mex. (33);	5	Cottonwood Creek—Wyo. (75)	4	Whitewater Draw—Ariz. (34)	1
Tex. (7)	6	New Fork—Wyo. (30)	5	Vamori (Valshni) Wash—Ariz. (52)	2
Llano River—Tex. (8)	7	South Piney Creek—Wyo. (41)	6		
Brazos River direct—N. Mex. (34); Tex. (9)	8	La Barge Creek—Wyo. (42)	7	Great Basin, total—Oreg.; Idaho; Wyo.;	VIII
Little River—Tex. (10)	9	Fontenelle Creek—Wyo. (43)	8	Utah; Nev.; Calif.	
San Jacinto River—Tex. (11)	10	Sandy Creek—Wyo. (39)	9	Bonneville Lake, total—Idaho; Utah; Nev.;	VIII-A
Trinity River—Tex. (12)	11	Bitter Creek—Wyo. (49)	10	Wyo.	
Sabine River direct—Tex. (13); La. (11)	12	Blacks Fork direct—Utah (22); Wyo.	11	Great Salt Lake direct—Idaho (53);	1
Neches River—Tex. (14)	13	(48)	12	Nev.; Utah (1)	2
Calcasieu River direct—La. (12)	14	Muddy Creek—Wyo. (47)	13	Bear River direct—Utah (2); Wyo. (46);	3
Bundick Creek—La. (13)	15	Hams Fork—Wyo. (45)	14	Idaho (54)	4
Bayou Serpente—La. (14)	16	Henrys Fork—Utah (24); Wyo. (58)	15	Thomas Creek—Wyo. (25); Idaho (55)	5
West Fork Calcasieu River—La. (15)	17	Yampa River direct—Colo. (10)	16	Little Bear River—Idaho (56);	6
Mormontau River direct—La. (16)	18	Elk River—Colo. (7)	17	Utah (3)	7
Nesque Bayou—La. (17)	19	Trout Creek—Colo. (11)	18	Maled River—Idaho (57); Utah (4)	8
Bayou Quade de Tortue—La. (18)	20	Little Snake River—Wyo. (59);	19	Weber River direct—Utah (5)	9
Verdell River—La. (19)	21	Colo. (8)	20	Chalk Creek—Utah (6)	10
Atochafalaya River direct—La. (20)	22	Brush Creek—Utah (25)	21	East Canyon Creek—Utah (7)	11
Bayou Teche direct—La. (21)	23	Ashley Creek—Utah (26)	22	Ogden River—Utah (8)	12
Bayou Boeuf—La. (22)	24	Duchene River—Utah (27)	23	Jordan River direct—Utah (9)	13
Bayou Lafourche—La. (23)	25	White River—Colo. (23); Utah (28)	24	Utah Lake direct—Utah (10)	14
Lake Pontchartrain	26	Willow Creek—Utah (29)	25	Spanish Fork system—Utah (11)	15
Amite River—La. (24)	27	Price River—Utah (30)	VI-A-Con.	Provo River system—Utah (12)	16
Natalbany River—La. (25)	28	San Rafael River—Utah (31)	22	Sevier River	
Tangipahoa River—La. (26)	29	Fremont River direct—Utah (32)	23	Upper Sevier River direct—Utah (13)	14
Chefume River—La. (27)	V	Muddy River—Utah (33)	24	East Fork Sevier River direct—	
Rio Grande		Escalante River—Utah (34)	VI-Ab	Utah (14)	15
Upper Rio Grand direct—Colo. (57);	V-A	San Juan River direct—Colo. (64);	1	Otter Creek—Utah (15)	16
N. Mex. (14)		N. Mex. (35); Utah (35); Ariz. (2)		San Pitch River—Utah (16)	17
		Piedra River—Colo. (79)			

NAMES OF DRAINAGE BASINS WITH INDEX NUMBERS—Continued

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Great Basin—Continued		Columbia River—Continued		Columbia River—Continued	
Bonneville Lake—Continued		Upper Columbia River—Continued		Lower Columbia River direct—Wash. (1);	IX-C
Sevier River—Continued		Clark Fork—Continued		Oreg. (1)-----	1
Lower Sevier River—Utah (17)-----	18	Upper Clark Fork—Mont. (56)-----	3	Walla Walla River—Oreg. (15); Wash. (22)	2
Deep Creek (Box Elder County, Utah)---	19	Blackfoot River—Mont. (57)-----	4	Umatilla River direct—Oreg. (16)-----	3
Idaho (65); Utah (47)-----	20	Bitterroot River—Mont. (58)-----	5	Butter Creek—Oreg. (17)-----	4
Grouse Creek—Nev.; Utah (48)-----	21	Flathead River direct—Mont. (59)-----	6	Willow Creek—Oreg. (19)-----	5
Thousand Spring Creek—Nev. (51); Utah	22	Swan River—Mont. (60)-----	7	John Day River direct—Oreg. (20)-----	6
Deep Creek (Tooele County, Utah)—Nev.	23	Little Bitterroot River—Mont. (61)-----	8	Rock Creek—Oreg. (21)-----	7
(35); Utah (49)-----	24	Priest River—Wash. (3); Idaho (51)-----	9	Deschutes River direct—Oreg. (22)-----	8
Snake Valley—Nev. (36); Utah (50)-----	25	Kettle River—Wash. (4)-----	10	Squaw Creek—Oreg. (23)-----	9
Beaver River—Utah (51)-----	26	Colville River—Wash. (5)-----	11	Crooked River—Oreg. (24)-----	10
Little Salt Lake—Utah (52)-----	27	Spokane River direct—Idaho (45);	12	White River—Oreg. (25)-----	11
Coal Creek—Utah (53)-----	28	Wash. (6)-----	13	Fifteenmile Creek—Oreg. (26)-----	12
Escalante Desert—Nev.; Utah (54)-----		Coeur d'Alene River—Idaho (46); Wash.	16	Klickitat River—Wash. (25)-----	13
Shoal Creek—Nev.; Utah (55)-----		Latah Creek—Idaho (49); Wash. (7)-----	17	Hood River—Oreg. (27)-----	14
Lahontan Lake Basin, total—Oreg.; Nev.;	VIII-B	Sanpoil River—Wash. (8)-----	18	White Salmon River—Wash. (24)-----	15
Calif.-----	VIII-Ba	Okanogan River—Wash. (9)-----	19	Sandy River—Oreg. (28)-----	16
Northern Great Basin, total—Oreg.; Nev.;		Methow River—Wash. (10)-----	20	Willamette River direct—Oreg. (29)-----	17
Calif.-----		Lake Chehalis—Wash. (11)-----	21	Calapooya River—Oreg. (30)-----	18
Malheur Lake:		Entiat River—Wash. (12)-----	22	Santiam River—Oreg. (31)-----	19
Silvies River—Oreg. (50)-----	1	Wenatchee River—Wash. (13)-----	23	Luckiamute River—Oreg. (32)-----	20
Harney Lake direct—Oreg. (51)-----	2	Crab Creek—Wash. (14)-----	24	Yamhill River—Oreg. (33)-----	21
Silver Creek—Oreg. (52)-----	3	Yakima River direct—Wash. (15)-----	25	Mollalla River—Oreg. (34)-----	22
Donner and Blitzen River—Oreg. (53)-----	4	Naches River—Wash. (16)-----	26	Tualatin River—Oreg. (35)-----	23
Benjamin Lake—Oreg. (54)-----	5	Ahtanum Creek—Wash. (17)-----	IX-B	Clackamas River—Oreg. (36)-----	24
Silver Lake—Oreg. (55)-----	6	Snake River-----	1	Lewis River—Wash. (25)-----	25
Summer Lake—Oreg. (56)-----	7	Upper Snake River direct—Idaho (1)-----	2	Cowlitz River—Wash. (26)-----	26
Lake Abert—Oreg. (57)-----	8	South Fork Snake River direct—Wyo.	3	Klamath River direct—Oreg. (45); Calif. (3)-----	X
Cowhead and Warner Lakes—Calif. (81);	9	(14); Idaho (2)-----	4	Williamson River direct—Oreg. (46)-----	1
Nev. (50); Oreg. (58)-----	10	Gros Ventre River—Wyo. (26)-----	5	Sprague River—Oreg. (47)-----	2
Trout Creek—Oreg. (59)-----	11	Grays River—Wyo. (28)-----	6	Lost River—Calif. (4); Oreg. (48)-----	3
Whitehouse Creek—Oreg. (60)-----	12	Salt River—Wyo. (27); Idaho (3)-----	7	Shasta River—Calif. (5)-----	4
Black Rock Desert—Nev. (48)-----	13	Henrys Fork direct—Wyo. (69);	8	Scott River—Calif. (6)-----	5
Quinn River direct—Nev. (49)-----	14	Idaho (4)-----	9	Trinity River—Calif. (7)-----	6
McDermitt Creek—Nev.; Oreg. (61)-----	15	Teton River—Wyo. (13); Idaho (5)-----	10		
Tennille Creek—Oreg. (62)-----	16	Grays Lake—Idaho (6)-----	11	Pacific Ocean streams, excl. Gulf of Calif.	
Surprise Valley—Nev. (51); Calif. (82)-----	17	Blackfoot River—Idaho (7)-----	12	streams and Columbia and Klamath Rivers-----	XI
Madeline Plains—Calif. (83)-----	18	Portneuf River—Idaho (8)-----	13		
Smoke Creek—Calif. (85); Nev. (52)-----	19	Bannock Creek—Idaho (9)-----	14	Pacific Ocean streams north of the	
Sierra Nevada Slope, total—Nev.; Calif.	VIII-Bb	Lower Snake River direct—Idaho (10);	15	Columbia River-----	XI-A
Pyramid Lake direct—Nev. (16)-----	1	Oreg. (2); Wash. (18)-----	16	Puget Sound direct—Wash. (27)-----	1
Truckee River direct (upper)-----	2	Raft River—Utah (45); Idaho (11)-----	17	Nisqually River—Wash. (28)-----	2
Calif. (87); Nev. (17)-----	3	Goose Creek—Nev. (1); Utah (46);	18	White and Puyallup Rivers—Wash. (29)-----	3
Steamboat and Washoe Valleys-----	4	Idaho (12)-----	19	Lake Washington—Wash. (30)-----	4
Nev. (19)-----	5	Salmon Falls Creek—Nev. (2);	20	Snohomish River—Wash. (31)-----	5
Truckee Canal—Nev. (18)-----	6	Idaho (13)-----	21	Skagit and Samish Rivers—Wash. (32)-----	6
Carson River (upper)—Calif. (88);	7	Little and Big Wood Rivers direct—	22	Dungeness River—Wash. (33)-----	7
Nev. (20)-----	8	Idaho (14)-----	23	Nooksack River Area—Wash. (34)-----	8
Truckee and Carson Rivers (lower)-----	9	Camas Creek—Idaho (15)-----	24	Sumas River—Wash. (35)-----	9
Nev. (21)-----	10	Bruneau River—Nev. (3); Idaho (16)-----	25	Chehalis River—Wash. (36)-----	10
Walker Lake direct—Nev. (22)-----	11	Boise River direct—Idaho (17)-----	26	Other Pacific Slope streams in	
Walker River direct—Nev. (23)-----	12	North Fork Boise River—Idaho (18)-----	27	Washington—Wash. (37)-----	11
West Walker River—Calif. (89);	13	South Fork Boise River—Idaho (19)-----	28	Pacific Ocean streams between the Columbia	
Nev. (24)-----	14	Moore Creek—Idaho (20)-----	29	and Klamath Rivers-----	XI-B
East Walker River—Calif. (90);	15	Owyhee River direct—Idaho (21);	30	Rogue River direct—Oreg. (37)-----	1
Nev. (25)-----	16	Oreg. (3)-----	31	Little Butte Creek—Oreg. (38)-----	2
Honey Lake—Nev. (55); Calif. (86)-----	17	South Fork Owyhee River direct—	32	Bear Creek—Oreg. (39)-----	3
Mono Lake—Calif. (91)-----	18	Nev. (5); Idaho (22); Oreg. (4)-----	33	Evans Creek—Oreg. (40)-----	4
Adobe Meadows—Calif. (92)-----	19	East Fork Owyhee River—Nev. (4);	34	Applegate River—Calif. (1); Oreg. (41)-----	5
Owens River—Calif. (93)-----	20	Idaho (23)-----	35	Illinois River—Calif. (2); Oreg. (42)-----	6
Central Great Basin and Eastern Nevada,	VIII-Bc	Jordan Creek—Idaho (24); Oreg. (5)-----	36	Umpqua River—Oreg. (43)-----	7
total—Nev.; Calif.-----		Malheur River direct—Oreg. (6)-----	37	Other Pacific Slope streams—Oreg. (44);	8
Humboldt River:		Bully Creek—Oreg. (7)-----	38	Calif. (11)-----	9
Upper Humboldt River direct—Nev. (6)-----	1	Willow Creek—Oreg. (8)-----	39	Pacific Ocean streams between the Klamath	
Lamoille and Rabbit Creeks-----	2	Payette River direct—Idaho (25)-----	40	River and San Francisco Bay-----	XI-C
Nev. (7)-----	3	North Fork Payette River—Idaho (26)-----	41	Mad River—Calif. (8)-----	1
North Fork Humboldt River—Nev. (8)-----	4	South Fork Payette River—Idaho (27)-----	42	Eel River—Calif. (9)-----	2
South Fork Humboldt River—Nev. (9)-----	5	Weiser River—Idaho (28)-----	43	Russian River—Calif. (10)-----	3
Maggie Creek—Nev. (10)-----	6	Burnt River—Oreg. (9)-----	44	Other coastal streams in northern	
Pine Creek—Nev. (11)-----	7	Powder River—Oreg. (10)-----	45	California—Calif. (11)-----	4
Middle Humboldt River direct-----	8	Imnaha River—Oreg. (11)-----	46	San Francisco Bay direct—Calif. (12)-----	1
Nev. (12)-----	9	Salmon River-----	47	Petaluma Creek—Calif. (13)-----	2
Reese River—Nev. (13)-----	10	Upper Salmon River direct—Idaho (29)-----	48	Sonoma Creek—Calif. (14)-----	3
Little Humboldt River—Nev. (14)-----	11	Pahsimeroi River—Idaho (30)-----	49	Napa River—Calif. (15)-----	4
Lower Humboldt River—Nev. (15)-----	12	Lenhi River—Idaho (31)-----	50	Suisun Bay direct—Calif. (16)-----	5
Sonoma and Clear Creeks—Nev. (47)-----	13	Lower Salmon River direct—Idaho (32)-----	51	Walnut Creek—Calif. (17)-----	6
Clover Valley—Nev. (52)-----	14	North Fork Salmon River—Idaho (33)-----	52	Alameda Creek—Calif. (18)-----	7
Ruby Valley—Nev. (53)-----	15	Panther Creek—Idaho (34)-----	53	Santa Clara Valley streams—Calif. (19)-----	8
Goshute and Steptoe Valleys—Nev. (54)-----	16	Middle Fork Salmon River-----	54	Pacific Ocean streams south of San	
Spring Valley—Nev. (57)-----	17	Idaho (35)-----	55	Francisco Bay-----	XI-E
Crescent, Diamond, Grass, and Newark	18	South Fork Salmon River—Idaho (36)-----	56	Streams between San Francisco Bay and	
Valleys—Nev. (58)-----	19	Little Salmon River—Idaho (37)-----	57	Santa Maria River-----	XI-Ea
Big Smoky Valley—Nev. (59)-----	20	Grande Ronde River direct—Oreg. (12);	58	Pajaro and San Benito Rivers-----	1
Ballston, Monitor, and Hot Creek	21	Wash. (19)-----	59	Calif. (20)-----	2
Valleys—Nev. (40)-----	22	Wallowa River—Oreg. (13)-----	60	Salinas River—Calif. (21)-----	3
Railroad Valley—Nev. (41)-----	23	Joseph Creek—Oreg. (14)-----	61	Other coastal streams north of Santa	
Smith Creek and Dixie Valleys—Nev. (46)-----	24	Asotin Creek—Wash. (20)-----	62	Maria River—Calif. (35)-----	4
Fish Lake Valley—Calif. (94); Nev. (45)-----		Clearwater River direct—Idaho (38)-----	63	Santa Maria River and streams south-----	XI-Eb
Amargosa River and Dry Lakes—Nev.		Selway River—Idaho (40)-----		Santa Maria River—Calif. (22)-----	1
(44); Calif. (95)-----		South Fork Clearwater River-----		San Antonio River—Calif. (23)-----	2
Antelope Valley—Calif. (97)-----		Idaho (41)-----		Santa Ynez River—Calif. (24)-----	3
Mojave River—Calif. (98)-----		Palouse River—Idaho (44); Wash. (21)-----		Ventura River—Calif. (25)-----	4
		Mud Lake direct—Idaho (58)-----		Santa Clara River and Calleguas	
Columbia River-----	IX	Camas Creek direct—Idaho (59)-----		Creek—Calif. (26)-----	5
Upper Columbia River direct—Wash. (1)-----	IX-A	Beaver Creek—Idaho (60)-----		Los Angeles and San Gabriel Rivers-----	6
Kootenai River—Mont. (54); Idaho (52)-----	1	Medicine Lodge Creek—Idaho (61)-----		Calif. (27)-----	7
Clark Fork direct—Mont. (55); Idaho (50);	2	Birch Creek—Idaho (62)-----		Santa Ana River—Calif. (28)-----	
Wash. (2)-----		Little Lost River—Idaho (63)-----			
		Big Lost River—Idaho (64)-----			

GENERAL DISCUSSION

LXV

NAMES OF DRAINAGE BASINS WITH INDEX NUMBERS—Continued

(For the 17 western States and Arkansas, Louisiana, and Florida. State and composite maps, "Irrigation—by Drainage Basins—1939," available from the Superintendent of Documents, Washington, D. C.)

NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables	NAME OF DRAINAGE BASIN AND INDEX NUMBERS FOR STATE MAPS AND STATE BASIN TABLES	Index num- bers for composite map and summary tables
Pacific Ocean streams, excl. Gulf of Cali- fornia streams and Columbia and Klamath Rivers—Continued		Sacramento-San Joaquin Delta and tributary streams—Continued		Sacramento-San Joaquin Delta and tributary streams—Continued	
Pacific Ocean streams south of San Francisco Bay—Continued		Sacramento-San Joaquin Delta direct—Con.		Sacramento-San Joaquin Delta direct—Con.	
Santa Maria River and streams south—Con.		Sacramento River—Continued		San Joaquin River direct—Continued	
Santa Margarita River—Calif. (29)-----	8	Upper Sacramento River direct—Con.		Kern River direct—Continued	
San Luis Rey River—Calif. (30)-----	9	Paynes Creek—Calif. (46)-----	10	Foso Creek and White River—	32
San Dieguito River—Calif. (31)-----	10	Redbank Creek group—Calif. (47)-----	11	Calif. (68)-----	33
San Diego River—Calif. (32)-----	11	Antelope and Mill Creeks—		Tule River and Deer Creek—Calif. (69)	34
Swetwater River—Calif. (33)-----	12	Calif. (48)-----	12	Kaweah River—Calif. (70)-----	35
Otay and Tia Juana Rivers—Calif. (34)-----	13	Thomas Creek—Calif. (49)-----	13	Panoche and Los Gatos Creeks group—	
Other coastal streams south of Santa		Deer Creek—Calif. (50)-----	14	Calif. (71)-----	36
Maria River—Calif. (35)-----	14	Middle Sacramento River direct—		Kings River—Calif. (72)-----	37
San Jacinto River—Calif. (99)-----	15	Calif. (51)-----	15	Fresno River—Calif. (73)-----	38
		Rock Creek—Calif. (52)-----	16	Merced River—Calif. (74)-----	39
		Stony Creek—Calif. (53)-----	17	Orestimba and Los Banos Creeks group—	
		Chico Creek—Calif. (54)-----	18	Calif. (75)-----	40
		Butte Creek—Calif. (55)-----	19	Tuolumne River—Calif. (76)-----	41
		West Side streams—Calif. (56)-----	20	Stanislaus River—Calif. (77)-----	42
		Feather River direct—Calif. (57)-----	21	Calaveras River—Calif. (78)-----	43
		Yuba and Upper Bear Rivers—		Mokelumne River—Calif. (79)-----	44
		Calif. (58)-----	22	Cosumnes River—Calif. (80)-----	
		Lower Bear River—Calif. (59)-----	23		
		Lower Sacramento River direct—		FLORIDA	
		Calif. (60)-----	24	St. Marys River (1)-----	1
		American River—Calif. (61)-----	25	St. Johns River and North Atlantic slope (2)	2
		Cache Creek—Calif. (62)-----	26	Kissimmee and Caloosahatchee Rivers (3)-----	3
		Putah Creek—Calif. (63)-----	27	Everglades (4)-----	4
		San Joaquin River direct—Calif. (64)-----	28	Aucilla River (11)-----	11
		Avenal and El Paso Creeks group—		Suwanee River (12)-----	12
		Calif. (65)-----	29	Withlacoochee River (13)-----	13
		Caliente Creek—Calif. (66)-----	30	Tampa Bay (14)-----	14
		Kern River direct—Calif. (67)-----	31	Peace Creek (15)-----	15
Sacramento-San Joaquin Delta and tributary streams-----	XII				
Sacramento-San Joaquin Delta direct— Calif. (37)-----	1				
Sacramento River:					
Upper Sacramento River direct—					
Calif. (38)-----	2				
Pit River direct—Calif. (39)-----	3				
Goose Lake—Oreg. (49); Calif. (40)-----	4				
Clear Creek—Calif. (41)-----	5				
Cow Creek—Calif. (42)-----	6				
Bear Creek—Calif. (43)-----	7				
Cottonwood Creek—Calif. (44)-----	8				
Battle Creek—Calif. (45)-----	9				