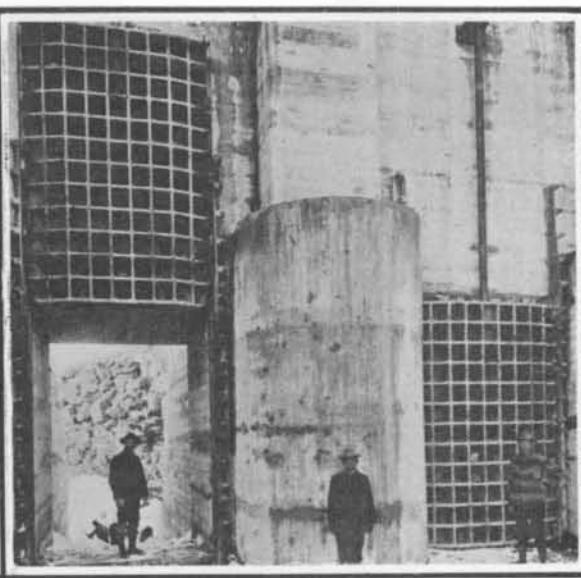
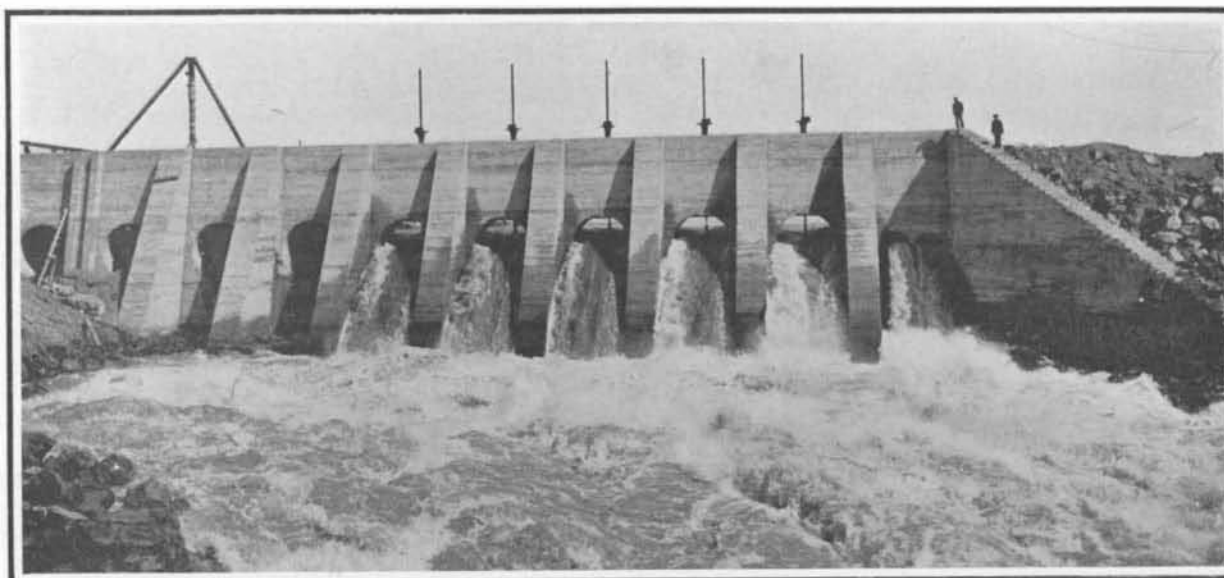


The Reclamation of the Arid Lands of the West.

the progress of the work has been made thoroughly familiar to the people of the United States by the brush and camera of the artist and the ever-ready pen of the descriptive writer.

We must not make the mistake, however, of sup-

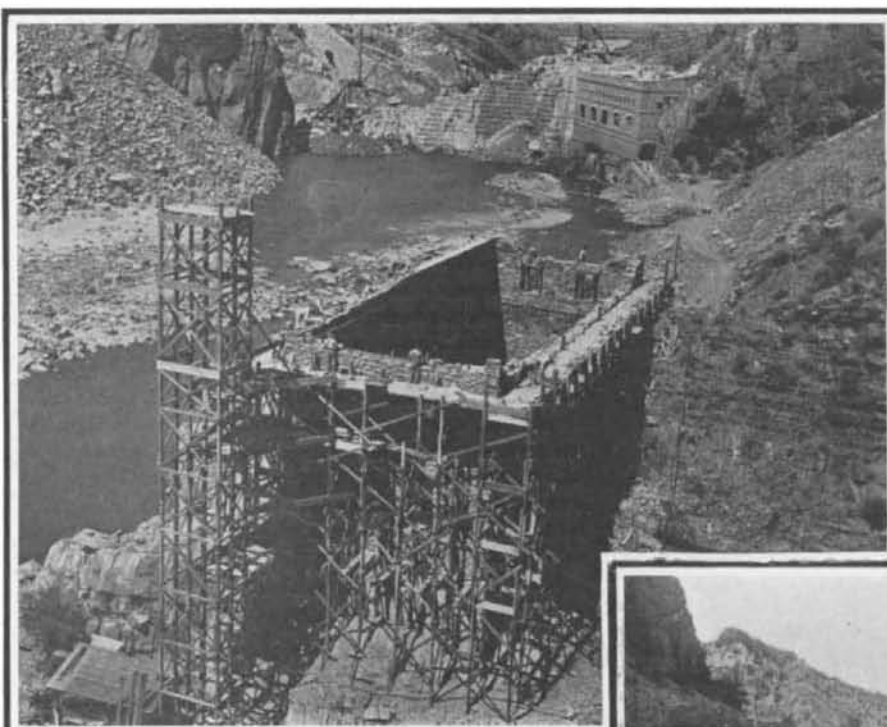
posing that the history of irrigation in the United States dates from the year 1902, when the government decided to apply its vast resources to the problem. For its beginning we must go back to the remote and unwritten past, even to the romantic age of the cliff



This view shows 22,000 second-feet passing through five 8 x 12 foot gates and five large and two small penstock openings in diversion channel.

Two of the 8 x 12-foot coffin gates in diversion channel dam.

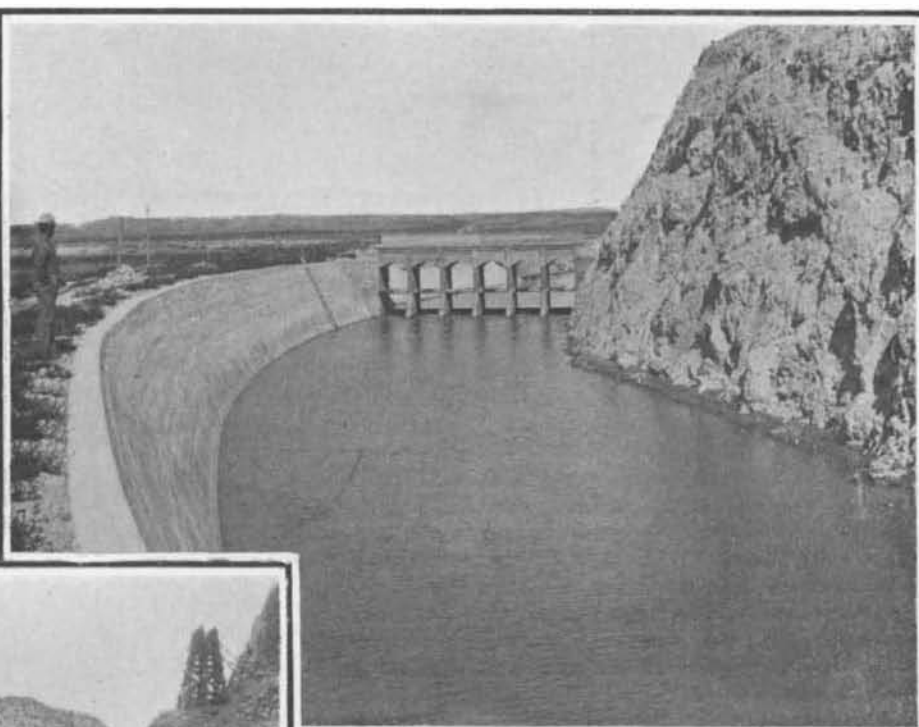
MINIDOKA PROJECT, IDAHO.



Height of dam, 234 feet. Impounds 1,234,000 acre-feet of water. Will irrigate 210,000 acres. The power house is shown in the foreground.

ROOSEVELT DAM, SALT RIVER PROJECT, WYOMING.

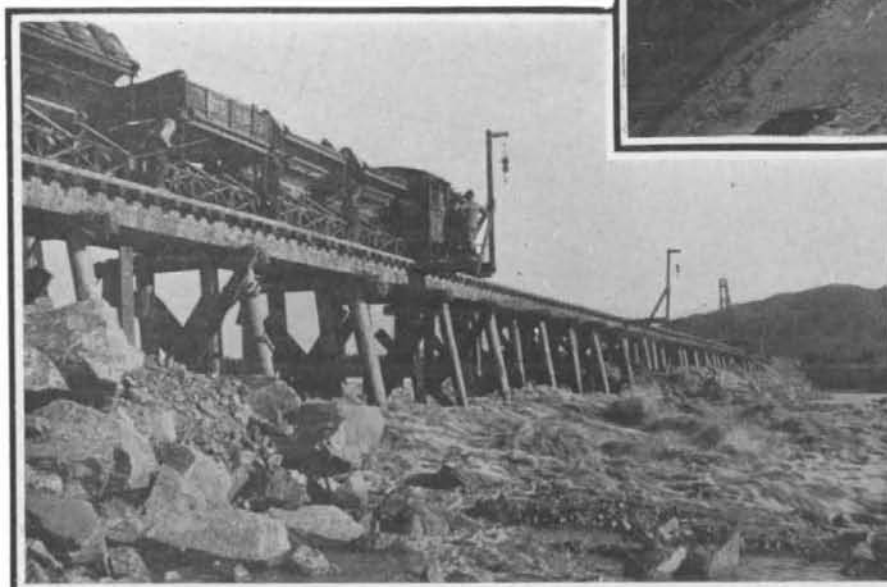
Of all the public works undertaken by the United States government, there is probably none that is more popular than the noble scheme for the reclamation of the arid and semi-arid lands of the West. The story of the construction of huge artificial reservoirs, far-reaching canals, and costly tunnels, for the storage of the flood waters and their conveyance to barren lands which await only the magic touch of the irrigation ditch to develop their wonderful fertility, is one of fascinating interest; and



Interstate waterway at Mollies Fork.

NORTH PLATTE PROJECT, NEBRASKA-WYOMING.

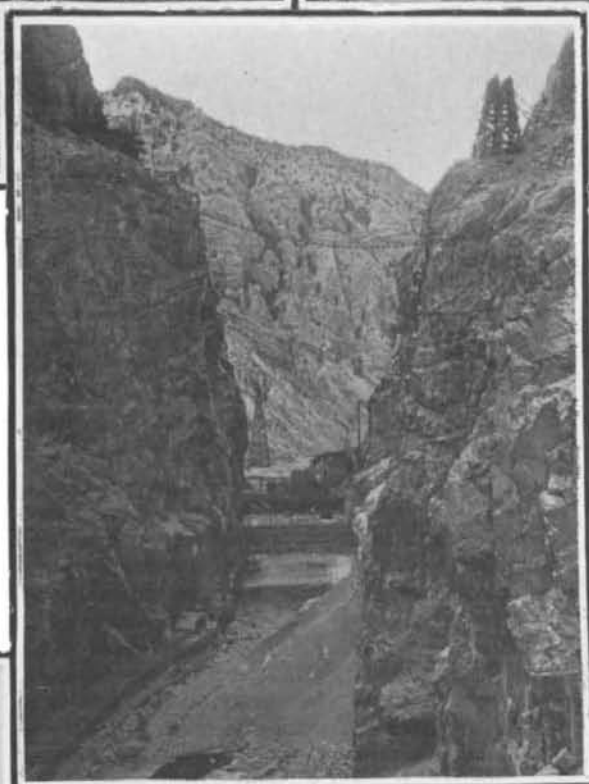
dwellers; for there is clear evidence that in the valleys of New Mexico there once existed a complete system of irrigation canals, that served to render these now desolate districts both fertile and populous. For reasons which we do not know, and probably never shall, these ancient and highly developed races degenerated; their homes fell into decay; and their great engineering works became obliterated. Centuries later, with the advent of the Spanish settlers, irrigation was reintroduced in southern California and in the lower valley of the Rio Grande. The mission fathers, also, by the aid of small dams and canals, rendered



Trainloads of rock were dumped into the stream.

View of work on the upper trestle, Dec. 19th, 1908.

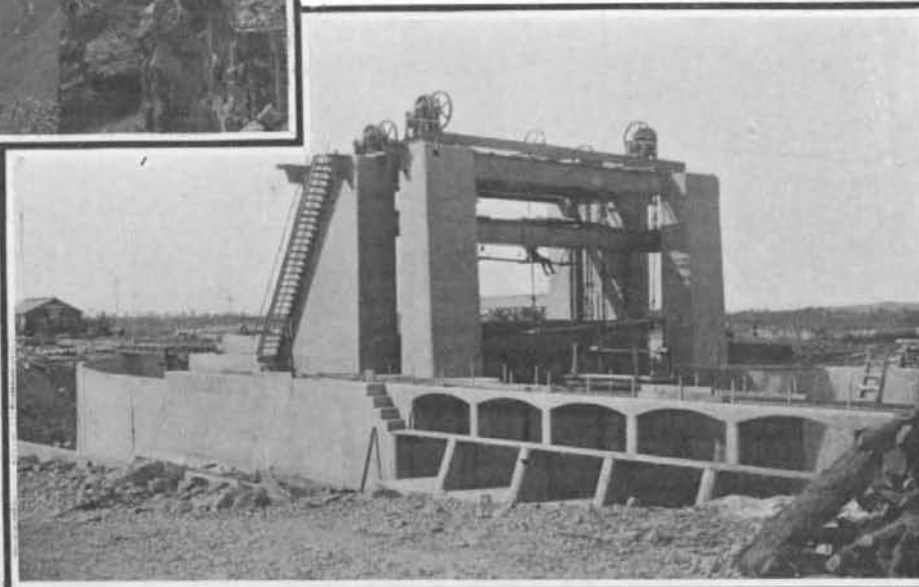
CLOSING THE COLORADO RIVER.



Dam, 310 feet high. Irrigates 100,000 acres

Shoshone dam looking up canyon.

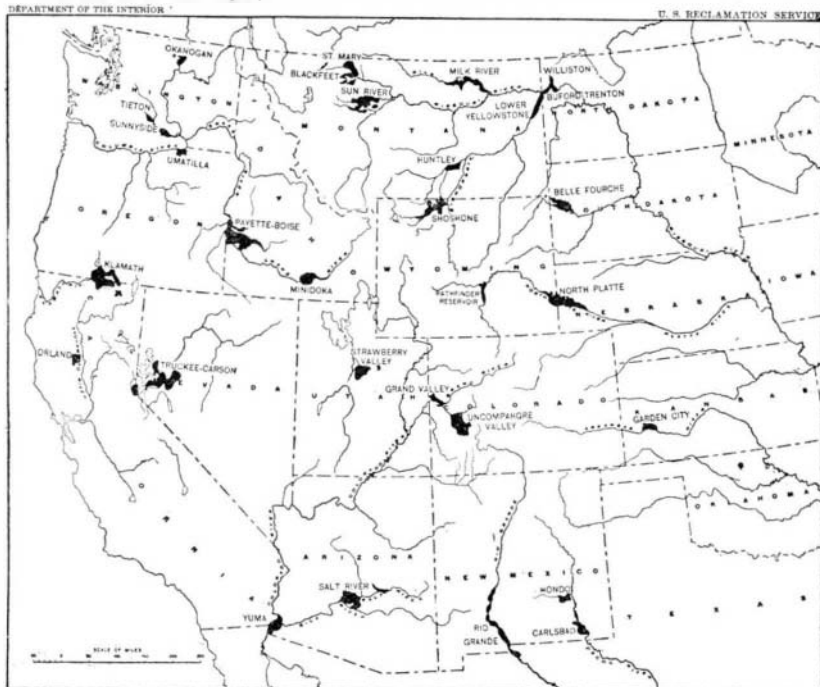
SHOSHONE PROJECT, WYOMING.



This project will irrigate at first 100,000 acres.

Laguna dam, Yuma project, California.

GATES AND REGULATOR OF ARIZONA SLUICWAY.



MAP SHOWING IN BLACK PRINCIPAL IRRIGATION PROJECTS IN THE WESTERN STATES.

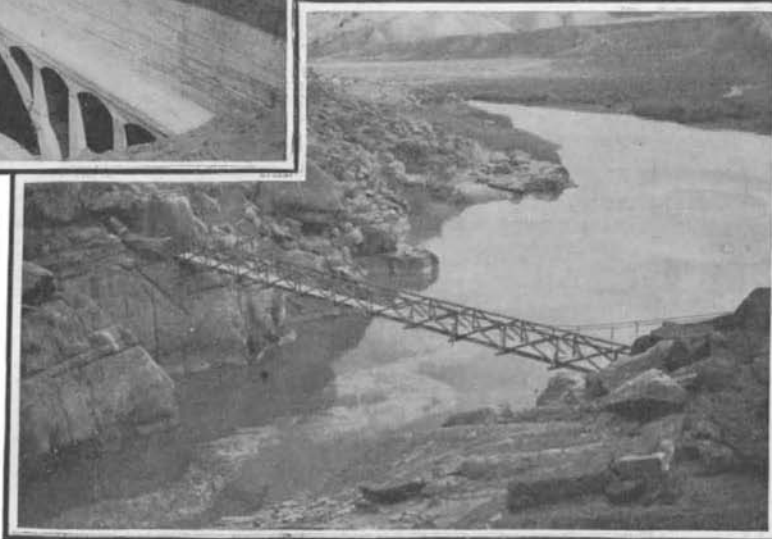
fruitful certain local areas in California.

The first successful attempt to apply irrigation to the arid regions is to be credited to the Mormons, who in 1847 made their notable settlement on the barren lands of the great interior basin, on the site where now stands Salt Lake City. With the growth of the colony, the work of leading in water from the various outlying streams was extended, and work has been carried on with such good effect that the present extensive system has been pronounced by the Department of Commerce and Labor to be "the most efficient in the country." Many of the pioneers of California turned from mining to irrigated farming, and the work has subsequently been extended to other States, until at the present time over eight million acres of land, which at one time was looked upon as worthless desert, is under cultivation and is producing crops each year, whose worth is estimated at over \$100,000,000.

There are four regions of the United States in which irrigation is practised: The arid region, comprising those States and Territories in which agriculture depends almost entirely upon irrigation; the semi-arid region, lying midway between the Rocky Mountains and the Mississippi River, where the rainfall is uncertain; the rice-producing States, comprising parts of Texas, Louisiana, the Carolinas, and Georgia; and the humid States, represented by several of the New England, Middle Atlantic, and Gulf States, where there is



Concrete flume which carries inter-state canal across Spring Canyon.



Footbridge across North Platte River, Pathfinder dam.

This project irrigates 110,000 acres.

and 5,788 acres in the humid States, making a total for the whole country of 9,487,077 acres. The number of farms included in these systems were 134,036, and the

a limited amount of irrigation. A Government Report of irrigation in the United States in 1902 showed that in the arid States and Territories 8,471,641 acres were under irrigation; in the semi-arid States and Territories, 403,449 acres; in the rice States of the South, 606,199 acres;

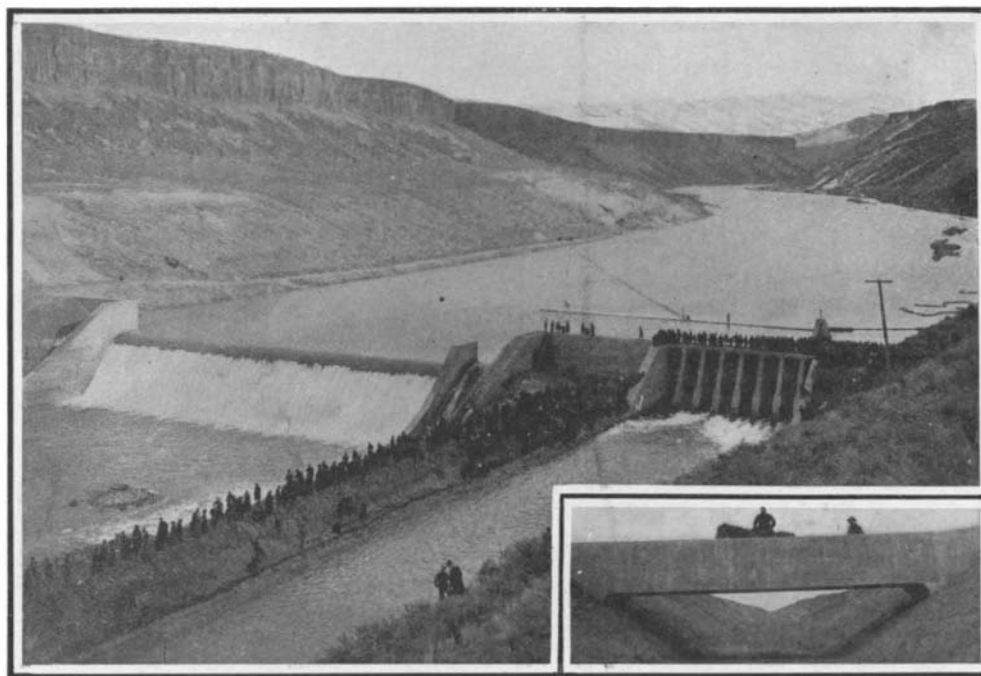
total cost of the work \$93,320,453. Practically, the whole of this work has been done by private enterprise. It includes irrigation of every kind, from the ambitious scheme of the large corporation down to the individual irrigation ditch of the small farmer. The whole of this work is due to private enterprise, unaided by the government.

Naturally, private enterprise has attacked the problem in those districts where the physical obstructions were the least and in which the water could be impounded, or large rivers tapped, and the supply brought to the land to be irrigated with the least possible expenditure of time and money. There still remained vast areas of arid and semi-arid land, estimated at some thirty million acres in all, which, if the necessary engineering skill and large amount of capital could be found for executing the necessary works, might be rendered fruitful and opened up for settlement.

In 1902 the government decided to undertake this great work of reclamation, and Congress passed a law providing that the money received

from the sale of public lands in the States lying within the arid region be set aside as a reclamation fund, to be used in surveys and in the construction and maintenance of irrigation work. A law was passed providing that the reclaimed lands were to be sold in tracts of not less than 40 or more than 160 acres. Under its terms, the settlers are to buy their lands direct from

(Concluded on page 432.)



Dam and headworks seven miles from Boise. PAYETTE-BOISE PROJECT.

Concrete flume over main canal. HUNTLEY PROJECT, MONTANA.

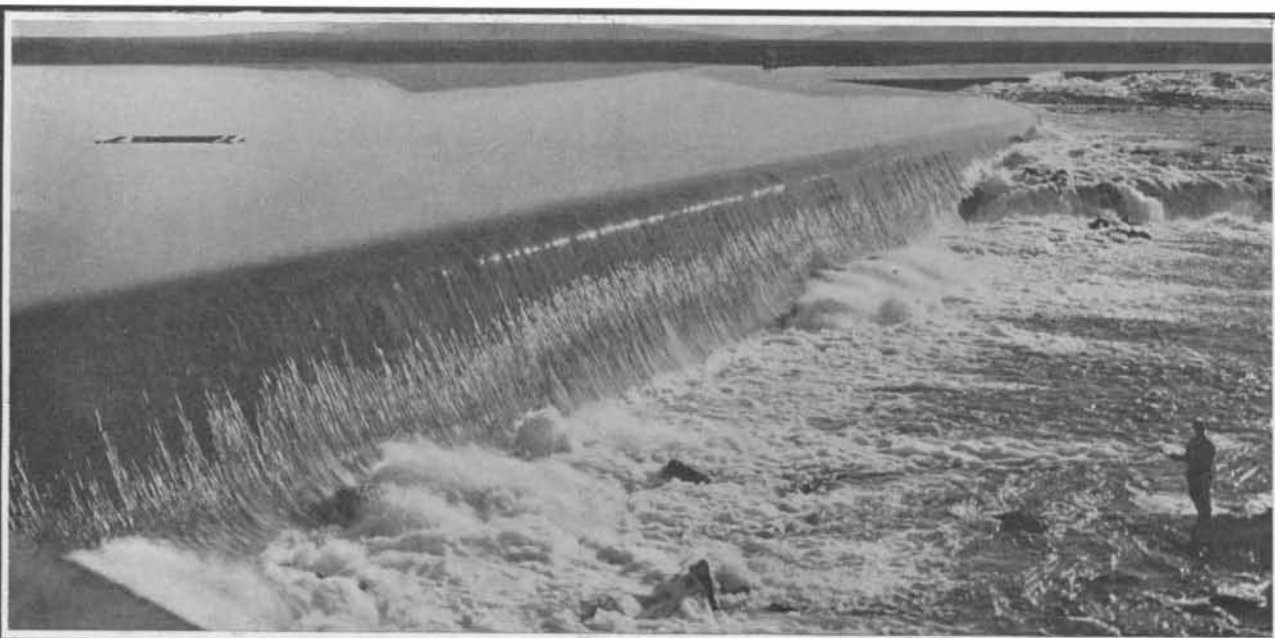


Pathfinder dam, 215 feet high, during construction.

THREE VIEWS OF NORTH PLATTE PROJECT, NEBRASKA-WYOMING.



The dam and regulating gates.



The spillway at south end of dam.

THE MINIDOKA PROJECT, IDAHO, IRRIGATING 160,000 ACRES BY 1911.

THE RECLAMATION OF THE ARID LANDS OF THE WEST.

(Concluded from page 429.)

the government, instead of obtaining them by rent or purchase from land and irrigation companies. The price of the land is determined by the cost of the irrigation works for that particular district, and the funds thus obtained are turned into the general Reclamation Fund, and used for the construction of work in other districts. The settlers pay for the land in installments, and payment must be completed by the end of ten years. In addition to paying for the land, the farmer is subjected to an annual charge for the water, and the money so received is also applied to the maintenance and improvement of the work. It can thus be seen that the fund is made self-perpetuating.

The general surveys for this wonderful work have been made, and the scheme includes some twenty-eight different "projects," as they are called, the location of which is indicated on the accompanying map by shaded areas. We also present a table, which gives the area in acres and estimated cost of such part of each project as will be completed by the year 1911. They vary in size from the Salt River project in Arizona, which will bring 210,000 acres under cultivation by the year 1911, at a cost of \$6,300,000, down to the Garden City stream in Kansas, which will irrigate 8,000 acres at a cost of \$350,000. By the close of that year, nearly 2,000,000 acres will have been reclaimed, at a cost of \$70,000,000. The works are in various stages of progress. Some are under survey; a few have been only recently commenced; while others are practically completed and are already supplying water to certain sections of the areas served. At the present time over 1,000,000 acres are ready for irrigation, and certain areas, which a few years ago formed part of a dry and trackless desert, are now supporting about 21,000 people on farms whose fertility is in many cases truly phenomenal. A large number of towns have sprung up, and the newly-opened districts are being connected by branch lines with the trunk railroads.

The beneficent work of the government does not cease with the turning off the water into the canals. In each district it maintains farmers who are experienced in the local conditions, for the purpose of teaching the newcomers how to till their land suitably to the special conditions and requirements of the districts in which they have settled. Government demonstration farms have been established, upon which the fruits and cereals most adapted to the local conditions are raised.

Now it must not for a moment be supposed that the two million acres of land to be brought under irrigation by 1911 represent the whole of the government scheme. As a matter of fact, it marks merely the beginning of a vast system, which contemplates the recovery of no less than thirty million acres. These are large figures; let us translate them into the terms of population and taxable value. It is estimated that a fair average value per acre of the irrigated farms, including the value of the land and of the improvements thereon, is \$150 per acre. If this is a conservative estimate it follows that the total value of the reclaimed land, when it has been brought under full cultivation, will be \$4,500,000,000. Not only will this vast property be added to the total taxable value of the farms of the United States, but judging from present condi-

powers which can be developed by utilizing the great available head of water on many of the projects. By January 1st, 1910, about fifty thousand hydraulic horse-power will be available. This belongs to the government, and will be sold to the settlers for power, light, and other purposes at the cost of production. So valuable is this asset alone, that it will make up the entire cost on some of the projects.

It is impossible within the limits of the present paper to do more than to give a brief outline of some of the more important of these great works.

YUMA PROJECT, CALIFORNIA.—This project consists in the diversion of the waters of the Colorado River by means of the Laguna Dam into two canals, one on each side of the river. The dam is located about ten miles northeast of Yuma, Arizona. These canals will irrigate all the bottom lands of the Colorado and Gila rivers in Arizona between Laguna Dam and the Mexican boundary, about 84,000 acres in all; and in California they will serve 17,000 acres of bottom lands in the Yuma Indian Reservation. This region resembles the fruitful valley of the Nile in its soil, climate, and droughts. The dam, which stretches entirely across the river, is remarkable more for its length than for its height. Unlike the huge Roosevelt, Shoshone, and Pathfinder dams, to be described later, it is an overflow weir, its purpose being to back up the waters of the Colorado sufficiently to provide a full supply for the two irrigating canals. By the year 1911 it will supply water to 100,000 acres at a cost of \$4,500,000.

SALT RIVER PROJECT, ARIZONA.—Of an entirely different character are the engineering works of the great Salt River project, by which, within two years from now, 210,000 acres will be irrigated at a cost of \$6,300,000. This project involves the construction of a storage dam, 284 feet in height, at Roosevelt, Arizona, which will impound 1,284,000 acre feet of water—that is to say, sufficient water to cover that number of acres one foot deep. The dam is most advantageously located in a deep and narrow canyon, whose bottom and sides are of rock. The storage basin of the dam, which will have a superficial area of 25.5 square miles, will be large enough to catch and store the waters of the great floods to which the Salt River, in common with most of the rivers of the arid regions, is liable. Because of the remoteness of the work, the construction of the dam has involved heavy incidental engineering expenses. It was necessary to cut a costly road over which to carry in the machinery and supplies; and because of the high price demanded in the bids for the supply of cement, the engineers were driven to the expedient of erecting a cement mill and manufacturing the cement on the spot. The water is released from the dam by massive gates. It flows down the canyon to a point forty miles below the dam, where it is diverted into two main canals, one on each side of the river. A power canal, 18.5 miles long, serves to develop electric power by which water will be pumped from underground sources, and increase the irrigable area by 50,000 acres, making 210,000 acres in all that will be brought under irrigation by 1911 at a cost of \$6,300,000.

SHOSHONE PROJECT, WYOMING.—Near the northern boundary of Wyoming, the government is building another remarkable dam, which has the distinction of being the loftiest structure of the kind in the world. It will rise 310 feet above its foundation; and so narrow is the canyon that the masonry will measure only 175 feet along its crest. Here, as at the Roosevelt Dam, it was necessary to cut a road many miles in length out of the solid rock in order to gain access to the site. The dam will create a reservoir with a storage capacity of 456,000 acre-feet, and by 1911 the water will be available on some 100,000 acres of choice land. The dam will regulate the flow of the water, and thirty miles below the dam the stream will be turned into a tunnel three and a quarter miles in length which will conduct it by a large canal into the district to be irrigated.

NORTH PLATTE PROJECT, NEBRASKA-WYOMING.—The third of the lofty dams is the structure known as the Pathfinder Dam, so named after the well-known explorer, Gen. John C. Fremont, who nearly lost his life at the site of the dam in trying to row through the canyon. Although the structure is about 100 feet less in height than the Pathfinder Dam, the storage basin above it is of such favorable formation that it will impound over 1,000,000 acre-feet, and will be capable of holding in check the greatest of the floods to which the restless North Platte is subject. Below the dam the government has built a great canal, 95 miles in length, which will carry the water to the irrigable lands of Wyoming and Nebraska. The broken character of the ground necessitated the construction of several important concrete viaducts, one of which is shown among our illustrations. Because of the porous nature of the soil the canal for many miles of its length is lined with concrete. By 1911 this system will have brought 110,000 acres under irrigation. When the whole scheme has been developed it will serve some 200,000 acres in Wyoming and an equal amount in Nebraska.

MINIDOKA AND PAYETTE-BOISE PROJECTS, IDAHO.—One of the most important works of the Reclamation Service is that which is being carried out on the Snake River in Idaho. At Minidoka a dam and regulating gate have been built across the river, and 130 miles of canal and 190 miles of ditches will serve to convey the water to 160,000 acres of land. Farther down the river, near the border line between Idaho and Oregon are the Payette-Boise works, which by the end of 1911 will bring 100,000 acres under cultivation. Ultimately, this project will reclaim 372,000 acres of land in the Payette, Boise and Snake rivers in southwestern Idaho.

UNCOMPAHGRE VALLEY PROJECT, COLORADO.—To the public mind the most spectacular of the irrigation works is that known as the Uncompahgre Valley, and this because of the great tunnel through the mountain recently opened by President Taft, which forms the most notable feature of the work. In southwestern Colorado the Uncompahgre and Gunnison rivers flow in approximately parallel courses, 10 miles apart, on either side of a mountain range some two thousand feet in height. The Uncompahgre, which is a comparatively insignificant stream, flows through a valley containing 700,000 acres of rich land, whereas the Gunnison, a much larger river, flows in a deep canyon, where there is practically no land available for cultivation. The United States engineers decided to cut a tunnel, 10½ feet by 12 feet in cross-section, for six miles through the mountain. The location of the tunnel was fixed at a point where the canyon is over half a mile deep. A road sixteen miles long was cut down this gorge, the machinery brought in, power plant established, and a few months ago the tunnel was completed. When President Taft opened the works the waters of the Gunnison River began to flow through the mountain, and emerged in a valley, where they will render fertile some 140,000 acres of rich soil.

In conclusion, we should again impress it upon the mind of the reader that the 2,000,000 acres, which will be brought under cultivation by the year 1911, represent only about one-fifteenth part of the fertile land which will ultimately be opened for settlement when the various schemes shown on the accompanying map have been worked out to their full development. So judiciously has the matter been handled by the United States Reclamation Service that the work will be self-supporting and self-perpetuating. So successful has that portion of it which is completed proved to be, that it is safe to say the work of reclaiming barren lands in the United States will go on until the whole of the arid lands upon which it is possible and profitable to bring the water have been brought under cultivation.

Limits of space prevent any extended reference to the nature and quantity of the crops that will be produced on these irrigated lands. In many sections the greater part of the acreage will be devoted to the raising of hay and forage, and particularly of alfalfa, for which there is a great demand as winter feed for cattle. The stock, which during the summer is fed upon the high pasture land, in the winter is driven down to the irrigated valley farms, where it feeds directly from the stack. Irrigated land yields about five tons of alfalfa to the acre and its average value is about \$5 per ton. As many as 300,000 head of sheep have been fed in this way in one winter on irrigated land near Billings, Montana. The fertility of the farms is something that must be seen to be appreciated. Average land in the East will yield 15 bushels to the acre. On irrigated land in Colorado the yield is 40 bushels. The Eastern farmer may gather in a year one hundred dollars' worth of apples from an acre, whereas on the irrigated land of the West the value of the crop will reach \$450 to the acre; and according to Mr. J. C. Blanchard, statistician of the United States Reclamation Service, apple orchards on irrigated land in the Yakima Valley have yielded from \$300 to \$1,200 per acre annually, while good orchard land sells at from \$300 to \$2,000 per acre, when containing full-bearing trees. In this same valley the value of farm products in 1907 reached the magnificent sum of \$3,625,000, and 65,000 cattle and 20,000 sheep, of a value of \$2,000,000, were ranged and fed.

With the purpose of studying enormously high voltages a short experimental transmission line has been built in Sweden which is adapted to operate at 500,000 volts. A special form of transformer is used to furnish this high electro-motive force. Circulating oil is used for insulation between the high and low-tension windings. The line is supported on the suspended type of insulators which are hung at a distance of 11 feet apart. Tests of the surface discharge showed that a wire of 10 square millimeters (0.0155 square inch) cross section would discharge at 35,000 volts; of 20 square millimeters at 50,000 volts, of 100 square millimeters at 200,000 volts, and of 250 square millimeters at 390,000 volts. As the tension was raised to 480,000 volts, the noise grew very loud and sparks leaped from the insulators. At night the glow of the discharge could be seen 2½ miles away.

TABLE SHOWING THE TWENTY-EIGHT PROJECTS OF THE RECLAMATION SERVICE.

The areas and costs are for such portions of the various projects as will be completed by 1911.

Location.	Project.	Area in Acres.	Estimated Cost.
Arizona	Salt River	210,000	\$6,300,000
California	Orland	30,000	1,200,000
California-Arizona	Yuma	100,000	4,500,000
Colorado	Uncompahgre	140,000	5,600,000
Colorado	Grand Valley	50,000	2,250,000
Idaho	Minidoka	160,000	4,000,000
Idaho	Payette-Boise	100,000	3,000,000
Kansas	Garden City	8,000	350,000
Montana	Huntley	30,000	900,000
Montana	Milk River, including Saint Mary	30,000	1,200,000
Montana	Sun River	16,000	500,000
Nebraska-Wyoming	North Platte	110,000	3,850,000
Nevada	Truckee-Carson	160,000	4,800,000
New Mexico	Carlsbad	20,000	640,000
New Mexico	Hondo	10,000	370,000
New Mexico	Leasburg	10,000	200,000
New Mexico-Texas	Rio Grande	160,000	8,000,000
North Dakota	Pumping, Buford	40,000	1,240,000
Montana-North Dakota	Lower Yellowstone	66,000	2,700,000
Oregon	Umatilla	18,000	1,100,000
Oregon-California	Klamath	120,000	3,000,000
South Dakota	Belle Fourche	100,000	3,500,000
Utah	Strawberry Valley	30,000	1,500,000
Washington	Okanogan	8,000	500,000
Washington	Sunnyside	40,000	1,600,000
Washington	Tieton	24,000	1,500,000
Washington	Wapato	20,000	600,000
Wyoming	Shoshone	100,000	4,500,000
		1,910,000	\$70,000,000

tions, it will provide homes for at least fifteen millions of people, one-half of them living on the farms, and the other half in towns and cities. Several of the latter have already been founded in the areas covered by the completed schemes, and are showing every evidence of healthy life and growth. Furthermore, the government will possess a valuable asset in the water