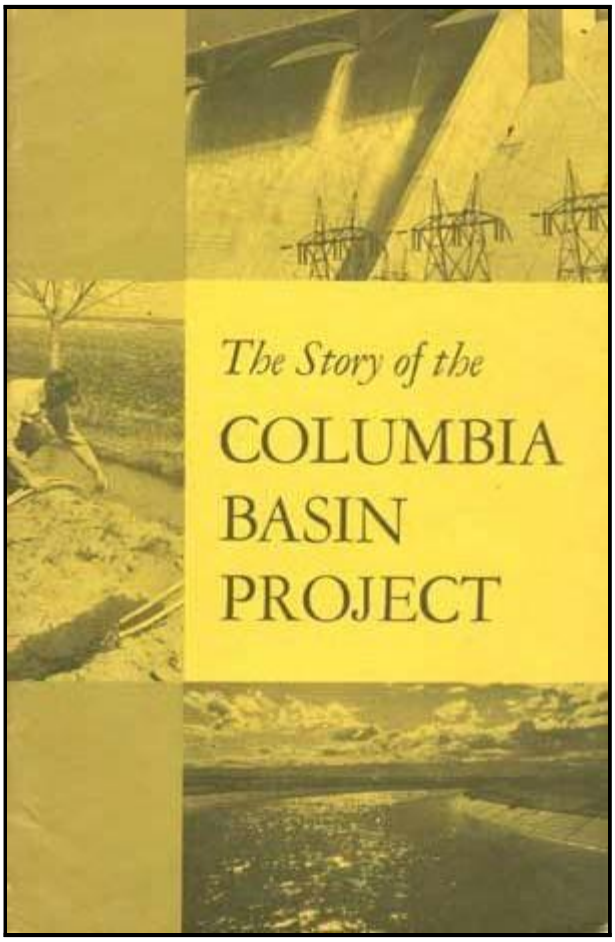


THE STORY OF THE COLUMBIA BASIN PROJECT

1964

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UNITED STATES DEPARTMENT OF THE INTERIOR
STEWART L. UDALL, *Secretary*

BUREAU OF RECLAMATION
FLOYD E. DOMINY, *Commissioner*



FOREWORD

This is the story of the Columbia Basin Federal Reclamation Project, of Grand Coulee Dam and Powerplant, and of the 1-million-acre-plus irrigation development.

Though often thought of as separate works, these two monuments of man's ingenuity and engineering ability are part of an overall plan to harness the power of a great river and reclaim a desert wasteland. Neither the dam nor the irrigation features of the project can be considered separately—they are interrelated in too many ways. Benefits to the economy of the Pacific Northwest, the increase in population, increased production of foodstuffs and manufactured articles, the increase in trade and commerce with Eastern States, all are joint products of the dam, powerplant, and the irrigation development of the project.

Information gained through the planning, building, and operation of Grand Coulee Dam and the Columbia Basin Project irrigation works is another product of this vast development and still serves as source material for students in many fields, since building a dam and irrigation works of this size went beyond existing experience and information. The Columbia Basin Project constantly posed new problems in its building and operation.

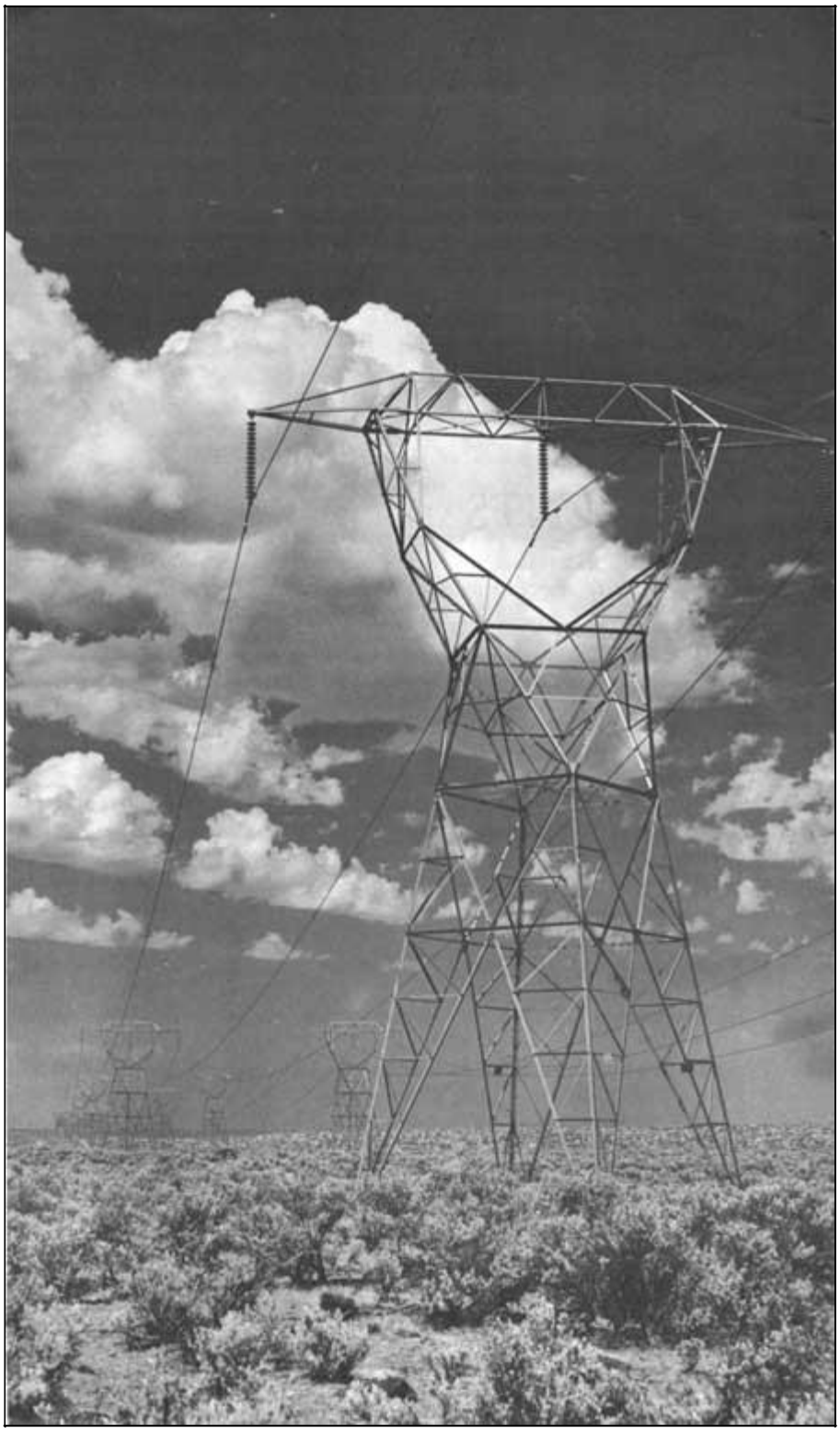
The engineering field as a whole benefited from the experience gained on the project, but hydraulic engineering especially gathered a wealth of new information. Farming of the rehabilitated desert lands of the project area has required new farming practices, and new strains of crops have been developed that are particularly suited to this region.

The economist and the community planner have learned a great deal from observing a wasteland turn into a prosperous farming area dotted with new and revitalized towns and cities. Sociologists and legal authorities have also learned lessons from new ideas embodied in regulations governing the project.

The many benefits from the Columbia Basin Project know no boundaries. The San Francisco businessman who lunches on split-pea soup, the Chicago housewife who shops for baking potatoes, the New York hostess who serves after dinner mints—all may be affected in some

measure by the produce of the Columbia Basin Project. The worker in the bauxite mines of Madagascar, the mechanic in a farm machinery factory in Illinois, the freight handler in a Michigan warehouse, the steelmill worker in Ohio, all find a reflection in their weekly paycheck of the expanded economy and purchasing power resulting from the Columbia Basin Project.

The purpose of this booklet is to illustrate further the effect that the Columbia Basin Project has had on the economy and lives of the people of the United States and the Pacific Northwest, as well as to describe its history and physical features. Material for this booklet has come from many sources. Pioneers who lived in the area prior to the inception of the project were interviewed, newspaper files were examined, and much information was taken from engineering reports, beginning with the first stages of construction and continuing up to the present day. The result is a short story of power, water, and people in this part of the Columbia River Basin in central Washington.



INTRODUCTION

Almost from his beginning, man has been aware of the vital role of water in the production of food. It is probable that the Egyptians were the first to make extensive use of irrigation. Pictures on monuments dating back about 4,000 years show men bailing water out of the Nile to pour on to their fields.

Years later, early irrigators began building canals to carry the water to their more distant fields. In many countries, China and Italy, for example, these canals were large enough to accommodate boats and were used both as a source of water for irrigation and an artery of transportation. Machines for lifting irrigation water into the fields were developed. Most of these machines seem crude and inefficient to modern eyes, but many of them are still used in China, India, and Egypt.



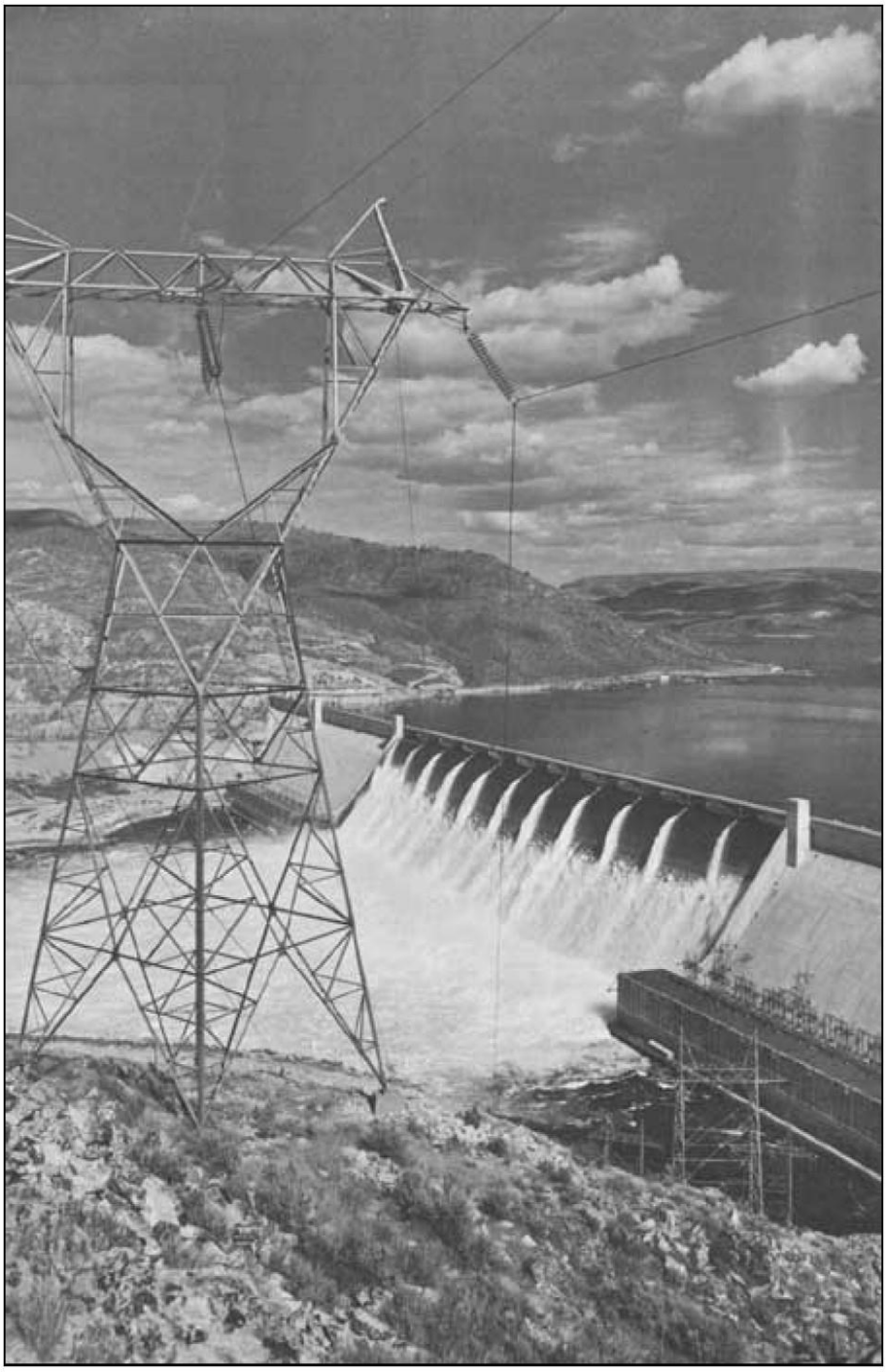
In addition to streams, early irrigators used natural lakes, ponds, wells, and springs as sources of irrigation water. The next logical step was the building of small dams to save the water for the dry season, when it was needed most for the fields. Low dams or weirs have been common place during much of the history of irrigation, and storage wells or tanks are still common today in India.

The very early settlers in eastern Washington State also used water from the streams and lakes of the area to irrigate their farms and orchards bec ause the rainfall was generally scarce. When Marcus Whitman arrived in southeast Washington in 1836, he found the fur traders irrigating vegetable gardens at the trading posts. He later used irrigation on a larger scale at his mission farm just east of Fort Walla Walla. The Oblate Fathers began using irrigation in the Yakima Valley in 1850, and shortly thereafter some irrigation farming was practiced in the Okanogan country to the north.



An aerial view of a very small fraction of the principal end goal of the project: farms for people to raise food for people.

Years later this same continuing quest for water to make the land productive was the driving force behind the building of Grand Coulee Dam. The electric power potential of the proposed dam was secondary. Primarily it was the belief that water from the Columbia River would turn the desert lands of the Columbia Basin into a prosperous and productive region that was responsible for the building of Grand Coulee Dam and the huge Columbia Basin Irrigation Project.



THE DAM

Sinews of power from the controlled Columbia River at Grand Coulee Dam help tum the wheels of northwestern industry and lift the river's waters to the Grand Coulee above, from

where they flow onto the parched lands of the Columbia Basin. This hydroelectric power and water, combined with the human and financial resources of the settlers, is turning a barren land into an economically substantial region.

Grand Coulee Dam and the Columbia Basin Irrigation Project have been hailed by the American Society of Civil Engineers as one of the seven engineering wonders of the United States. Together, they represent one of the greatest projects undertaken by man in his constant effort to make the world a better place in which to live.

Standing astride the mighty Columbia River like a Colossus of the new world, Grand Coulee Dam is a giant in a land of superlatives. Only after touring the installation and studying it from all angles does a realization of its bigness begin to dawn.

It is the largest concrete dam in the world, containing 10,585,000 cubic yards, or 21,154,000 tons, of concrete. It towers 550 feet from bedrock to the crest and tapers from a width of more than 450 feet at its base to 30 feet at its top.

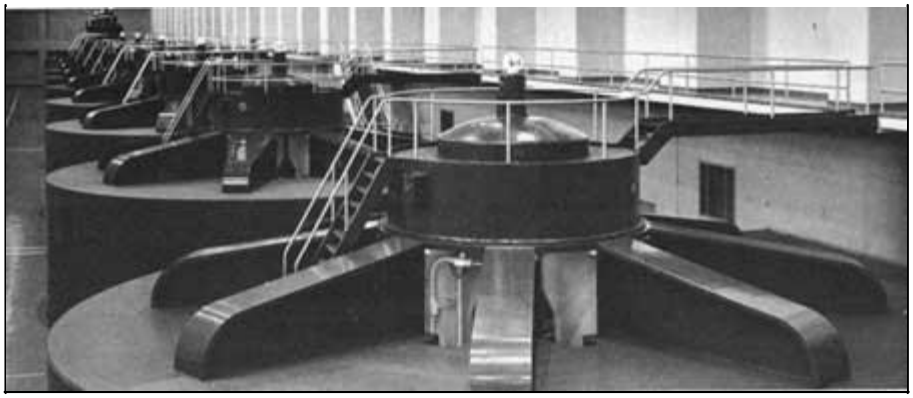


Excess water from Franklin D. Roosevelt Lake, behind the dam, plunges over the dam's spillway.

The dam reaches as high as the Washington Monument and contains enough material to build 275 monuments of the same size. Its immensity dwarfs the 2 powerhouses at its base, each of which is as tall as a 13-story office building. There is enough concrete in the dam to build a standard two-lane concrete highway 22 feet wide and 8 inches thick from Seattle to Miami, with a 3-foot sidewalk for pedestrians.

Seen from a car or the window of the tour center, Grand Coulee Dam is indeed impressive, but it becomes even more awesome as one inspects its interior. Here the visitor is soon impressed with the fact that there is a great deal more to building a dam than merely placing a block of concrete in the path of a river. The designers of Grand Coulee Dam had to solve an almost infinite number of problems, and the final design was the sum of experience and knowledge gained by the science of engineering down through the centuries.

Undoubtedly one of the most eye- and ear-catching features of the dam is the waterfall, which pours over the face of the dam during the summer. The overflow begins in the latter part of May and continues through August and occasionally into September, creating a waterfall more than half as wide as Niagara Falls. At the peak of the high water flow in a normal year, 135 million gallons of water a minute cascade over the spillway and through the gates of the dam and plunge twice as far as the Niagara River at Niagara Falls. At night the whole of this frothing curtain of water is illuminated by alternating colored lights.



These are the nine generators in the left powerhouse at Grand Coulee. Nine more generators are located in the right powerhouse. Each generator has a rated capacity of 108,000 kilowatts.

While the sight of thousands of tons of spilling water is thrilling and awesome, this is actually energy going to waste. One of the most important jobs of the dam is accomplished by the unseen torrents rushing through the turbines of the hydroelectric plants. In 1963 Grand Coulee Dam produced 12 billion kilowatt-hours of electricity.

In every 24-hour period at Grand Coulee there are periods of "high" and "low" power demand which reflect the dining, reading, working, television-viewing, and eating habits of a large portion of the people and industry of the Northwest.

The efficient operation of the hydroelectric plants at the dam to meet these power demands calls for a continuous flow of water to the generating units and sufficient "head" or depth of water in the reservoir behind the dam to turn the generating units. However, the Columbia River fluctuates a great deal from peak flow during the summer snowmelt to a low during the winter months, and the operation of the dam must be carefully planned to regulate water use and reservoir capacity in order to reap the greatest benefit from the river's power.

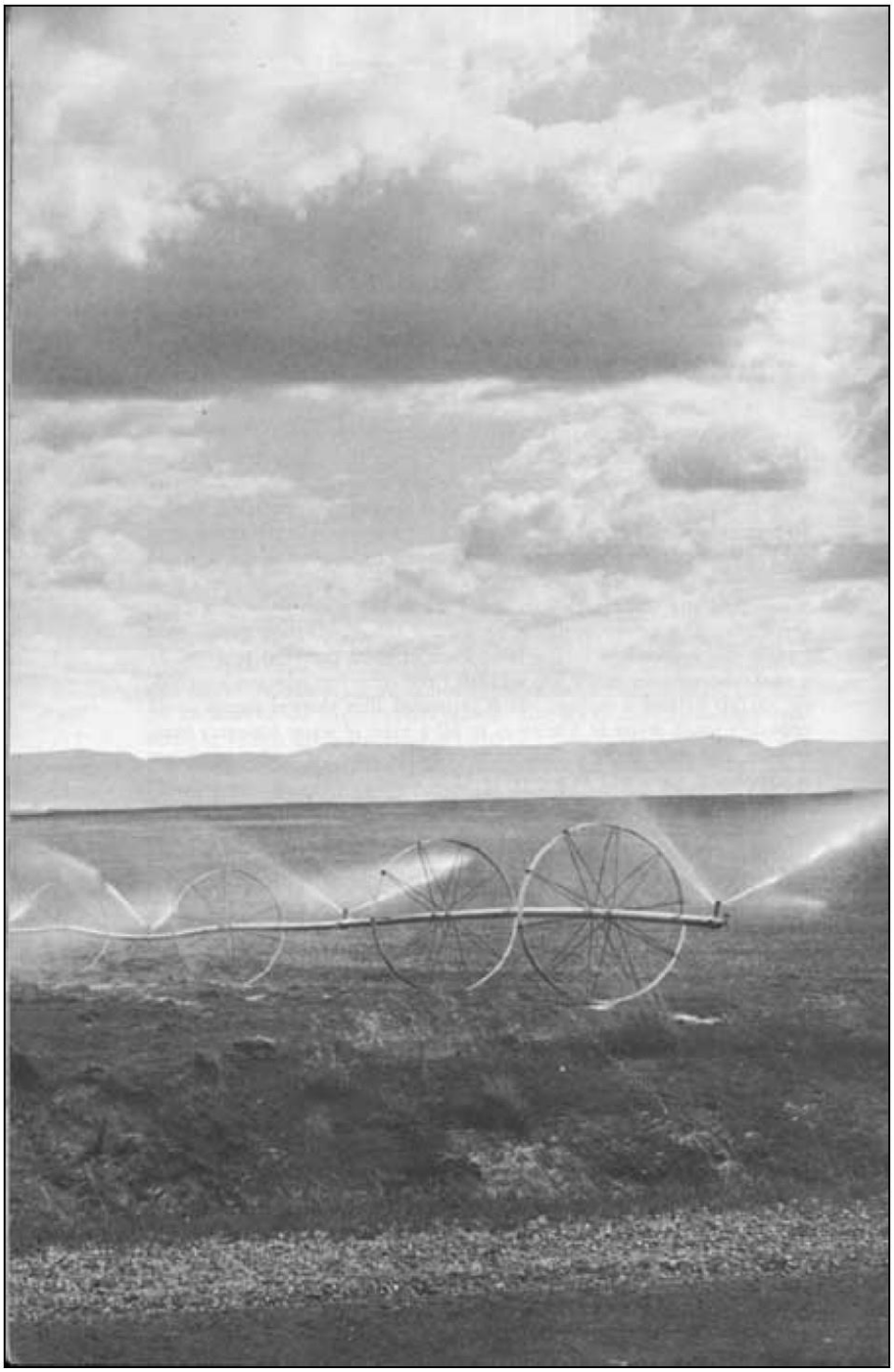
In the winter months water stored in the reservoir is used for power generation at Grand Coulee and at the downstream dams below Grand Coulee which have comparatively small storage reservoirs. In the spring when the Columbia River begins its annual rise, 80 feet of empty storage depth in the reservoir is available for use as a safety valve to partially absorb the force of potential spring floods. This flood-control operation of Grand Coulee has prevented a great deal of downstream property damage.



Twelve giant pipes scale the wall of the Columbia River Gorge at Grand Coulee, lifting irrigation water 280 feet from the reservoir behind the dam. Each pipe is 12 feet in diameter and can carry 720,000 gallons a minute. Only six pipes are being used at the project's present stage of development.

Circumstances have played no small part in the successful scheduling of Grand Coulee's workload. At about the time that the river starts its annual spring rise, the irrigation season begins. When the 6 powerful irrigation pumps just above the west end of the dam are operating, almost 10 percent of the average flow of the river is lifted over the rim of the river canyon wall 280 feet above the dam and begins its journey to the land and the crops of the irrigated portion of the project. Because of the higher water flow and consequently greater head in the reservoir at this time, there is surplus power available to operate the 6 irrigation pumps that handle this tremendous lifting job. Each of these pumps is powered by a 65,000-horsepower motor and will lift 1,600 cubic feet of water a second, or 720,000 gallons a minute. It is estimated that these 6 pumps could provide enough water in 3 minutes to fill a glass of water for every man, woman, and child in the United States. By the time the irrigation project is completed, there will be a total of 12 of these pumps.

This, then, is the Grand Coulee Dam. Structurally, it may be looked upon as a testimonial to its builders as a job well done and a monument to the wisdom of those farsighted persons whose persistence in their beliefs made this development possible. Functionally, it performs well the tasks for which it was designed—principally, to provide water for the Columbia Basin Irrigation Project, and power for the people and industry of the Northwest.



THE IRRIGATION SYSTEM

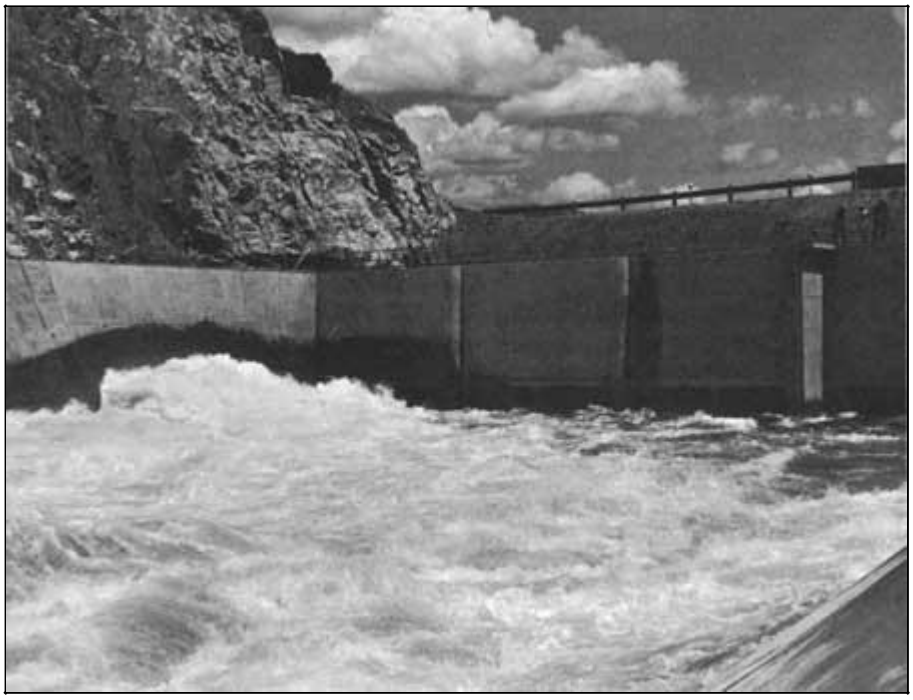
The Columbia Basin Project irrigation development embraces an area roughly twice the size of the State of Delaware. (See map in back.) Nearly half of this land is irrigable, with the

remainder being rough and unsuitable or taken up by townsites, airports, reservoir, and wasteways. Since the upper edge of the irrigated lands of the project is about 45 miles south and slightly west of Grand Coulee Dam, getting the water to the land, distributing it, and draining off the excess require an extensive system of waterways. Facilities have been constructed to provide irrigation water to farms comprising almost one-half of the ultimate !-million-acre-plus irrigation system.



The supply and distribution system for the project's irrigation water starts at Franklin D. Roosevelt Lake, the reservoir behind Grand Coulee Dam, and stretches south and west to the city of Pasco at the southern tip of the project, 160 miles away. A network of thousands of miles of waterways traverse the project area, bringing water to the fields and removing the excess.

At present, there are more than 2,000 miles of canals on the project. Included in this 2,000 miles of waterways are 16 large canal siphons and 2 tunnels, which carry the water of the Columbia across coulees and through barriers of high ground with little loss of elevation. The largest of these irrigation structures is the Soap Lake Siphon, which carries the waters of the West Canal across the lower end of the Grand Coulee. It is actually an inverted siphon which dips from the high ground to the east of Soap Lake, crosses the coulee in a semicircle around the northern end of the lake, and comes out on high ground to the west. This concrete tube is 12,883 feet long and has an inside diameter of 22 feet 4 inches for the major portion of the distance, with the remainder 25 feet in diameter. Though it will hold 41 million gallons of water, engineers say the water in it will change every 16 minutes when the water in the canal is flowing at full capacity.



Here the water from Franklin D. Roosevelt Lake, lifted by the pumping plant, begins its long journey to the irrigated portion of the project.

The project's irrigation water begins its long journey to the land when it is pumped up over the lip of the canyon wall at Grand Coulee Dam and flows into Banks Lake. The pumps lift the water at a rate of 4,300,000 gallons of water a minute. When the project is completed and all 12 pumps are working, this flow of water into the project's Feeder Canal will be almost doubled. Once in the Feeder Canal, the water flows along this 1.6-mile waterway to Banks Lake.



The project's Main Canal. During irrigation season the water here is 21 feet deep. The canal can carry 4,365,000 gallons of water a minute.

Banks Lake is an equalizing reservoir formed by sealing the north and south ends of an Ice Age channel in the Upper Grand Coulee. This 27-mile reservoir makes it unnecessary to regulate the pumping of water from Franklin D. Roosevelt Lake to meet daily irrigation requirements. Water can be pumped into this reservoir when both power and water are available and stored until needed for irrigation.

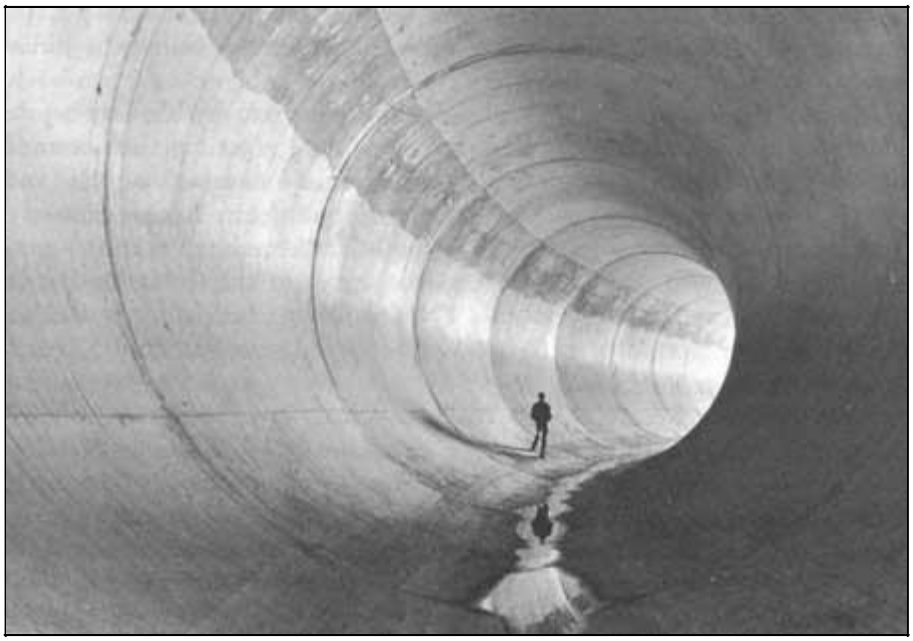
The dam at the north end of the reservoir is an earthfill dam, 1,450 feet long and 145 feet high. The south dam, known as Dry Falls Dam, is an earthfill dam also, 9,800 feet long, 123 feet high, and comfortably supports a two-lane transcontinental U.S. highway across its top.

The reservoir between these two dams is 27 miles long with a total storage capacity of 1,275,000 acre-feet of water. (An acre-foot is equal to 1 acre of water a foot deep, or 325,850 gallons.) Of the total volume of storage capacity of the reservoir, about 60 percent, or 761,800 acre-feet, is considered "active storage"—water which is above the lowest outlet of the dam. This is roughly 245 billion gallons of water, enough to cover the entire State of Rhode Island almost a foot deep.

The "active storage" of Banks Lake will be replaced seven to eight times a year when the project is completed, depending on such factors as the amount of rainfall the land receives, evaporation, and other conditions which govern the demand for irrigation water in the basin.

Normally, pumping into the reservoir begins in May or June and continues intermittently through August or September. The final weeks of pumping build up a reserve of water which can be used during the early fall and the following spring before pumping is resumed.

From the equalizing reservoir the water moves south through outlet gates in Dry Falls Dam near Coulee City, flows through 2 miles of main canal, crosses Bacon Coulee in the 1,038-foot-long Bacon Siphon, and enters the 10,045-foot-long Bacon Tunnel bored through a plateau of hard basalt rock. Pouring out of the tunnel, the water next flows through two ancient lake-beds, a concrete-lined canal, and the bed of a prehistoric river.



The Soap Lake Siphon carries the waters of the West Canal across the lower Grand Coulee near Soap Lake. The siphon is almost 2-1/2 miles long and over 22 feet in diameter.

Five miles below Bacon Tunnel, the water plunges 165 feet over a basalt cliff into the upper end of Long Lake Reservoir. Appropriately named "Summer Falls," the water pours over these cliffs only during the irrigation season. Normally, Long Lake Reservoir is used only as a waterway. However, if an emergency should call for a quick shutdown of the system, the reservoir can store water coming down the Main Canal until the system is in operation again or until the upstream headgates can be closed.

Continuing on its journey to the farms of the Columbia Basin, the water enters the Main Canal at the edge of the irrigable land. At this point it has traveled 15 miles from Banks Lake and is 44 miles south of the pumps at Grand Coulee Dam.

About 6-1/2 miles west and slightly south of Long Lake is the bifurcation works, where the Main Canal divides into the West Canal and the East Low Canal. The East Low Canal extends 87 miles from the bifurcation works down the eastern edge of the project and empties into the Scootenay Wasteway, which flows into Scootenay Reservoir. From the bifurcation works, the West Canal travels south and west to Soap Lake, where it jogs around the lake and crosses the Lower Grand Coulee via the Soap Lake Siphon, ending finally near Lower Goose Lake, 88 miles below the bifurcation works.

Much of the water in the Columbia Basin Project sees double duty before it returns to the Columbia River. It is used for irrigation, then drained off the land, recaptured by drains, wasteways, and natural channels, and then is used for irrigation a second time. Key structure in this economy operation is O'Sullivan Dam. This earthfill dam forms the Potholes Reservoir, directly south of Moses Lake in the center of the Columbia Basin. The dam is 3-1/2 miles long and rises 200 feet above bedrock. It has an "active storage" capacity of 379,500 acre-feet and covers about 45 square miles.

From Potholes Reservoir, the Potholes Canal flows southeast about 7 miles, then turns south to parallel the East Low Canal for about 15 miles. It passes west of Othello, then swings east to the Scootenay Reservoir, where it joins the waters of the East Low Canal. At the south end

of the reservoir, the Potholes Canal flows south and then southwest to supply irrigation water to thirsty lands before ending 6 miles northwest of Pasco.



A ditchrider travels the project's canals daily, turning water into the farmers ditches when needed and keeping an account of the amount of water used at each farm.

The Wahluke Branch Canal diverts from the Potholes Canal 6 miles south of Othello and passes through the Wahluke Siphon to serve the lands of the Wahluke Slope. This area slopes south from the Saddle Mountains to the Columbia River. It is about 40 miles long and varies from 5 to 10 miles wide. About 25 percent of this land, or approximately 42,000 irrigable acres, is in the safety control zone maintained by the Atomic Energy Commission. The Hanford Atomic Works is located across the river from the slope, and the control zone is maintained for safety in case of an accident that would cause radiation danger in the area.

These are the canals and reservoirs that form the main network of waterways that can now deliver water to almost half of the irrigable acres in the project area. Before the full project can be developed, there is still much work to be done. The East Low Canal, which will furnish water to the southeastern tip of the project, will have to be extended and the East High Canal, which will roughly parallel the East Low Canal and will serve water to the east of the area now irrigated by the East Low Canal, will have to be constructed.

Also, many miles of main and secondary waterways and related irrigation structures will have to be built throughout the project area. The pumping plant at Grand Coulee Dam will require 6 more pumps to lift the greater water volume into the irrigation system in order to serve the full project.

When completed, the total irrigated area of the Columbia Basin Project will be more than a million acres and will serve water to about 10,000 farms.



WHY PICK THIS LOCATION?

The formula for a successful irrigation project is a combination of many variables. The general layout of the land must lend itself to irrigation, and the soils and underlying rock

must provide fertility and the drainage necessary for farming. The length of the growing season of an area is a primary determiner of what crops can be raised in the area. Also, an irrigation project should be located on transportation routes so that products of the land can easily reach processing and marketing centers.

In the Columbia Basin, all of these factors have combined to make the area highly suitable for irrigation. The geology of the Columbia Basin Project makes a particularly interesting story.

The oldest rock on the project is the granitic rock which forms the hills to the north and east of Grand Coulee Dam and is the base on which the dam rests. This rock was formed deep within the earth's crust about 60 million years ago. Millions of years later, adjustments in the earth's crust and erosion by wind and water gradually exposed this granitic rock and established a river drainage system which flowed south out of Canada and across the eastern half of Washington before turning west to the Pacific Ocean.



Mint harvesting. The mint is chopped fine and loaded into a truck for processing.

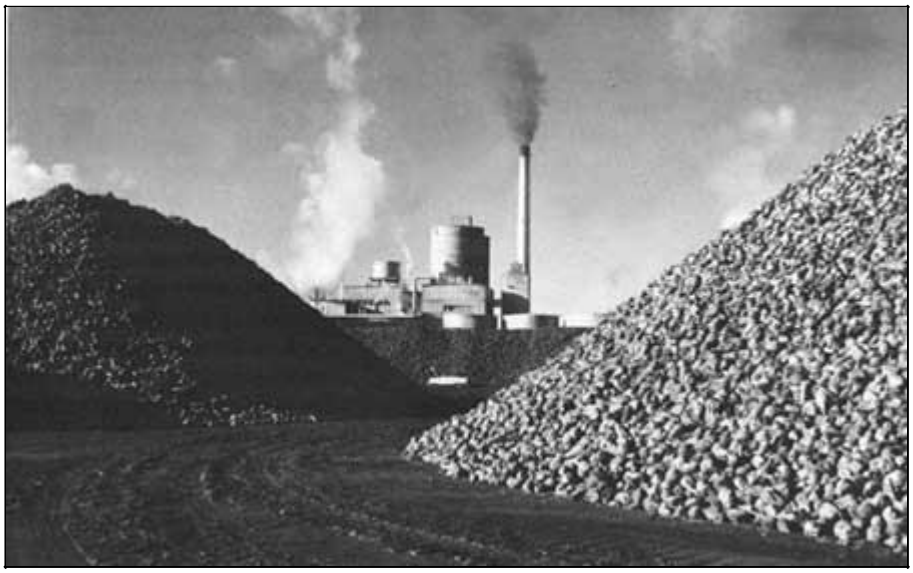
The next significant geologic event in the region was the extrusion of vast quantities of basalt lava through cracks in the earth's surface from depths of 30 to 50 miles. These outpourings of lava through numerous widespread fissures occurred time and again. Eventually a vast plain was formed on top of hundreds of horizontal layers of basalt, which today extend over the eastern part of Washington and into Idaho and Oregon. These basalt flows completely disrupted this area's southward-flowing streams and forced them westward into the present Columbia River system which skirts the northern and western margins of the basalt plateau that form what is locally called the "Big Bend."

The Ice Age brought great geologic changes to the area about a million years ago. A huge ice sheet which originated in Canada and the Canadian Arctic moved south, and the entire northern end of North America took on the appearance of present-day Antarctica, completely covered by ice except for the emergence of the highest mountain peaks.

In the Columbia Basin Project area the fringe of this ice front extended from Dry Falls, west of Coulee City, to Grand Coulee. Eastward from Grand Coulee the ice extended to Cheney, and westward from Coulee City it reached a point between Waterville and Mansfield.

For a while the large volumes of water that resulted from the melting of the edge of the ice

flow in the summer coursed down the established valley of the Columbia River. However, as the ice continued to move southward it blocked the Columbia River between Grand Coulee and Chelan, diverting the river and the meltwater into new watercourses southward along the Grand Coulee.



The multimillion-dollar Utah and Idaho Co. sugar plant near Moses Lake is the largest processing plant on the project.

These new streams and rivers, occupying courses which had never before been subjected to their powerful forces, settled downward in their new environments dramatically. Roaring waterfalls plunged over cliffs, formerly dry divides were crossed and incised, and the low-lying areas were covered with a coarse mixture of basalt debris and material carried into the region by glacial meltwater and icebergs.

The volume of water discharged across the eastern part of Washington varied widely from a winter trickle to huge floods which covered the land when large lakes of meltwater broke through temporary ice dams which blocked the Cabinet Gorge of the Clark Fork River. Under these conditions, the glacial streams never achieved a normal water flow and the result within the project area is a physiography that is unique, complex, awe-inspiring, and of great geologic interest.

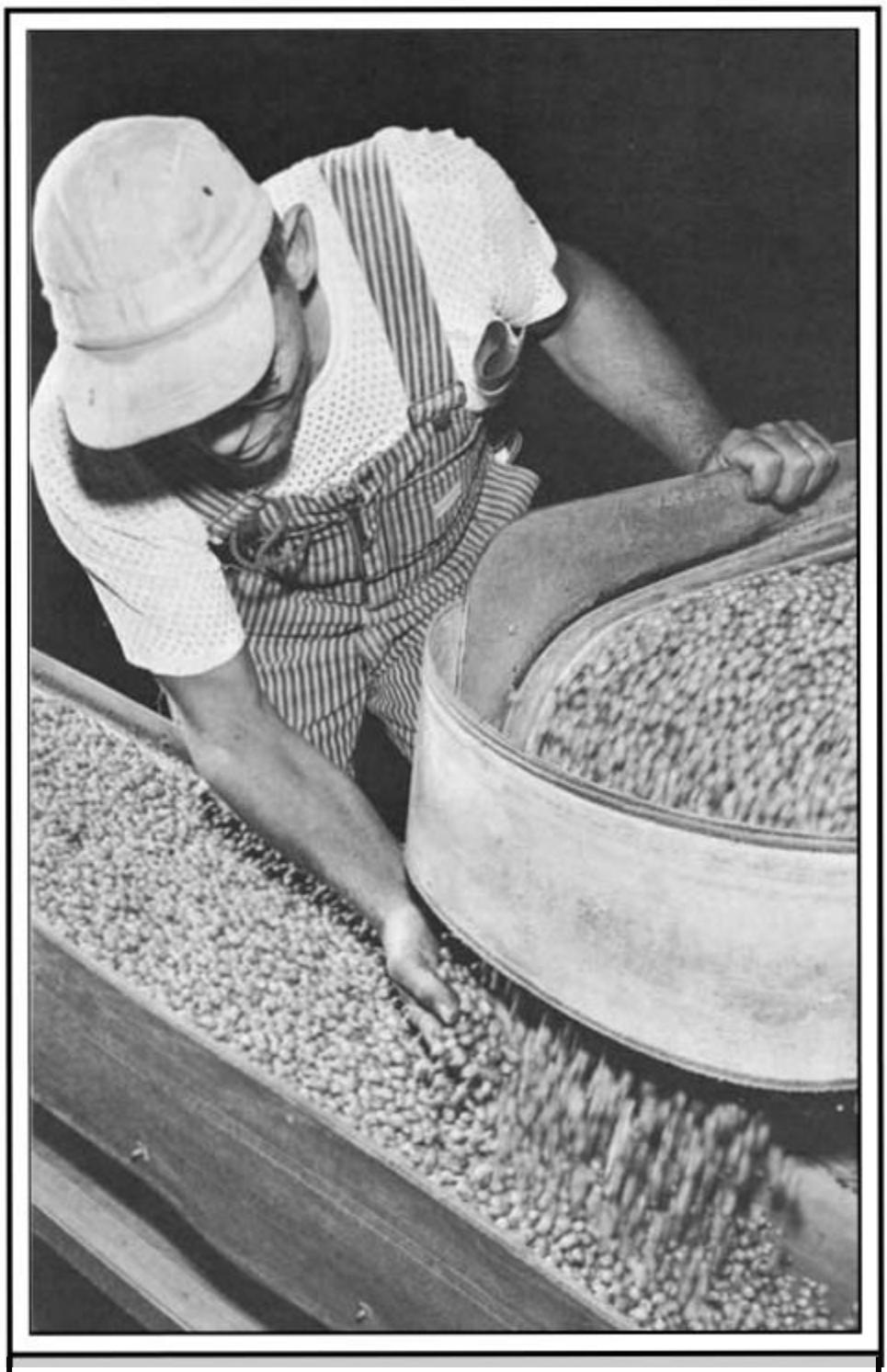
As successive annual and sporadic floods poured across the land, a huge waterfall which first plunged over the hill north of Coulee City eroded a waterway from the high Big Bend back into the Columbia River Valley to form the Upper Grand Coulee. The plunge at what is now Dry Falls took the river into the Lower Grand Coulee and thence meandering back to the present river channel.

As a result of the violent erosive forces and the massive grinding glaciers that shaped this area, today's soil composition in the basin varies widely from deep, fine, windblown materials with moderately low clay content to shallow sandy wind-deposited soils. Long periods of semiaridity during the project's formation resulted in the formation of a very hard calcium carbonate-sulfate caliche deposit in most subsoils usually covered by 18 inches to 15 feet of fertile soil. The soils of the project area are generally easily worked and low in alkali and other injurious chemicals. Given water, they make an excellent grass-roots host.

Without irrigation water the project area would certainly be hostile to crops, for the climate is

dry with much of the 6- to 10-inch rainfall that the area receives annually falling in the winter and early spring. Most of the moisture in the area is dropped on the Cascade Mountains before it reaches the basin.

The growing season, or frost-free period, in the project averages about 165 days and there are many areas in the project where the long frost-free period proves ideal for orchard and other crops that demand a long growing season. Winds over the project are strong, and contribute to the long crop-growing period by preventing the formation of frost pockets.



The production of pees for freezing offers a quick cash crop for settlers, and processing plants on the project provide part-time work for settlers and basin **families.**

These strong winds caused some trouble in the early days of the project by blowing away the topsoil of the newly cleared lands. However, the cropping of the land and the planting of permanent pasture and heavy cover crops have tied down the fine soil of the project and minimized dust-storms. For an irrigation project then, the climate of the basin area is very good.

Finally, as previously mentioned, an irrigation project must be located so that its produce can be easily exported to processing plants and markets. The approximate center of the irrigated lands of the Columbia Basin is 135 air-miles from Seattle, 105 miles from Spokane, and 150 miles from Portland. The area is served by seven major trucklines, four major rail lines, four branch rail lines, two buslines, and one airline. It is also crossed by three State highways, three Federal highways, and a network of county roads.

Markets of the world can be reached through the ports of Vancouver, Portland, and Seattle. Barges range upriver as far as Pasco at the south end of the project, where there are water terminal facilities.

In summary, the Columbia Basin Project was a "natural" for a successful irrigation development. Favorable geological conditions have made it a place of good land, abundant water, and a topography which lends itself well to transporting water to the land. A long, frost-free growing season allows the farmer to raise a large variety of crops, and a favorable location places him within easy reach of many of the major markets. These factors have helped to make the Columbia Basin Project a success and consequently a vital part of the Nation's economy.



THE SETTLER

On May 1, 1948, 3 years before irrigation water was due to flow through the Columbia Basin Project's Main Canal to make large-scale irrigation possible, irrigation water reached some

project lands via an irrigation canal from a pumping plant on the Columbia River at the southern tip of the project. Thus was the goal reached that project supporters had envisioned for years. But now that the land had water, it needed people; people to clear and level the land, enrich it, and build and buy farm irrigation facilities to properly apply the available irrigation water. On July 20, 1948, Public Announcement No. 1.1 was sent to 2,500 persons who had previously indicated an interest in the lands of this first irrigation block and, via the press wire services, the announcement was broadcast to the Nation.

For the 15 federally owned farm units in Irrigation Block 1, several hundred inquiries were received and 160 formal, 5-page applications filed by war veterans from half of the States in the country.

Each applicant was expected to have farming experience, be physically and mentally fit, and have good character references and a net worth of at least $3,700. All applications were carefully screened by a 3-member examining board, consisting of a project farmer from the South Columbia Basin Irrigation District, a veteran well acquainted with veterans' affairs (veterans were given preference for farm units), and a representative of the Bureau of Reclamation.

About 3 months later, on November 15, 1948, a public drawing was held in the auditorium of the Pasco Recreation Center, where the applicants received priority numbers. After an interview with Bureau officials some time later, 10 applicants selected their farms, from the available land, signed a land sale contract with the Government, and the land was theirs to develop.

That was drawing No. 1. Since 1948 to date, there have been a total of 35 such drawings held in fire stations, parks, and schools in large and small communities throughout the project area. The prerequisites for purchasing Federal farm units have changed a little—prospective settlers now must have a net worth of at least $8,500 and veterans no longer have preference. But the same basic procedure of selection is still followed.



Development of this land means a larger measure of prosperity for the Nation and a bright future for the project settler and his family.

Announcements are mailed and also published in the press, establishing a 45-day filing period. A drawing is held, and small capsules containing application numbers are pulled out of a goldfish bowl to establish selection priorities. Soon after, there always arrives that day when the lucky settlers, who have several choices of land, travel through the new irrigation block judging the land, imagining the location of their house and the equipment sheds, and digging their hands into the soil.

The proceedings, of course, are no longer observed with the festive aura of the first drawing, and each year when water first flows into newly developed land, the event may go largely unheralded. But interest in these new farm units has not waned. For the 1948 land sale, there were 160 applications for 15 farm units. In a recent sale of 18 farm units in a newly developed irrigation block, 451 applications were received. In a very real sense, this eagerness to obtain project land can be interpreted as an endorsement of the area's irrigated lands—for the present-day settler is not forced to speculate on what the land can do, he needs only look at the crops in a neighboring developed block to see what the land has done. Judging from the number of current applications, the prospect has obviously been a favorable one.

Although the methods and rewards of these Columbia Basin Project settlers are vastly different from their counterparts of many years past, the qualities of the people furnish a historic touchstone. It takes a special kind of person to move his family hundreds, perhaps thousands of miles to farm unproved lands only recently bisected by irrigation canals. Let's

take a look at Mr. Average Settler of the mid-1950's and his family as depicted by a 1956 sociological study.

The man is 40 years old and his wife is about 4 years younger. They have been married 15 years and have two or three children. The average settler and his wife came to the project with a good education. He spent 12.3 years in school, while the average educational level for farmers in the State at that time was 8.9 years and the national average was 8.6 years. His wife had an average of 12.4 years of schooling, also far above the State and national level. Overall, 25 percent of the settlers and their wives attended college and about 8 percent had degrees. Chances were one in three that he had studied vocational agriculture in high school and, if he attended college, that he had studied forestry or agriculture. One in every five settlers took part in the veterans farm training program and about the same number had attended short courses at a State college or had been in 4-H Club work.



Pioneer-like living quarters and facilities made housekeeping difficult for many project settlers while they were developing their farms.

Though not more than 1 percent of the early project settlers came to the basin without any previous farm experience, according to the study, 40 percent were not farming just prior to moving to the project. About 94 percent of the settlers and 60 percent of their wives had been reared on a farm. If the settler was one of those who had not recently been farming, he had been away from the farm about 13 years, and there is a 70-percent chance he was in a professional, proprietary, or managerial position, or that he was a skilled worker. The proportion of highly skilled people on the project is well above average for rural areas.

Although about half of these modern-day settlers were veterans, only one in four bought his farm from the Federal Government under veterans preference; many settlers bought their farms from private owners.

The modern-day settler arrives on the project with assets of about $24,000; he is well aware of the cost of beginning a farm enterprise. But, in spite of the efficiency and convenience of our modern equipment that money will buy, developing a farm in the Columbia Basin, as in any other area, still requires a great deal of physical labor. As on most family farms, the

settler's wife and children often work almost as hard as he does. In addition to her household work, the Columbia Basin Project settler's wife spends more time doing farmwork than her counterparts in other rural areas. She averages more than eighty 10-hour days during the year in some type of farmwork.

Most of the modern-day settlers of the Columbia Basin Project came from the Northwest and West to farm the newly irrigated project lands. More than half of them had lived in Washington, and two-thirds of these in south-central Washington. Almost a third came from Idaho, Oregon, and Montana, and the remaining Western States account for an additional 10 percent. The remaining 10 percent came from other parts of the Nation, and some even from foreign countries.



With continued delivery of irrigation water to the fields each year, the land has improved and the settler has prospered.

Why did the settler come to the basin? Most of those who came from a nonfarm job said that they came because they preferred farmwork and rural living. Those who had been farming elsewhere said that they felt the project offered more opportunity and a chance to develop a better farm. Others moved here from a tenant or sharecrop farm because the project offered a chance to build a farm of their own.

Surprisingly, the possibility of greater financial returns was a consideration of only a few. According to the study results, the average settler felt that the best part of farm life on the project was the independence and security it offered.

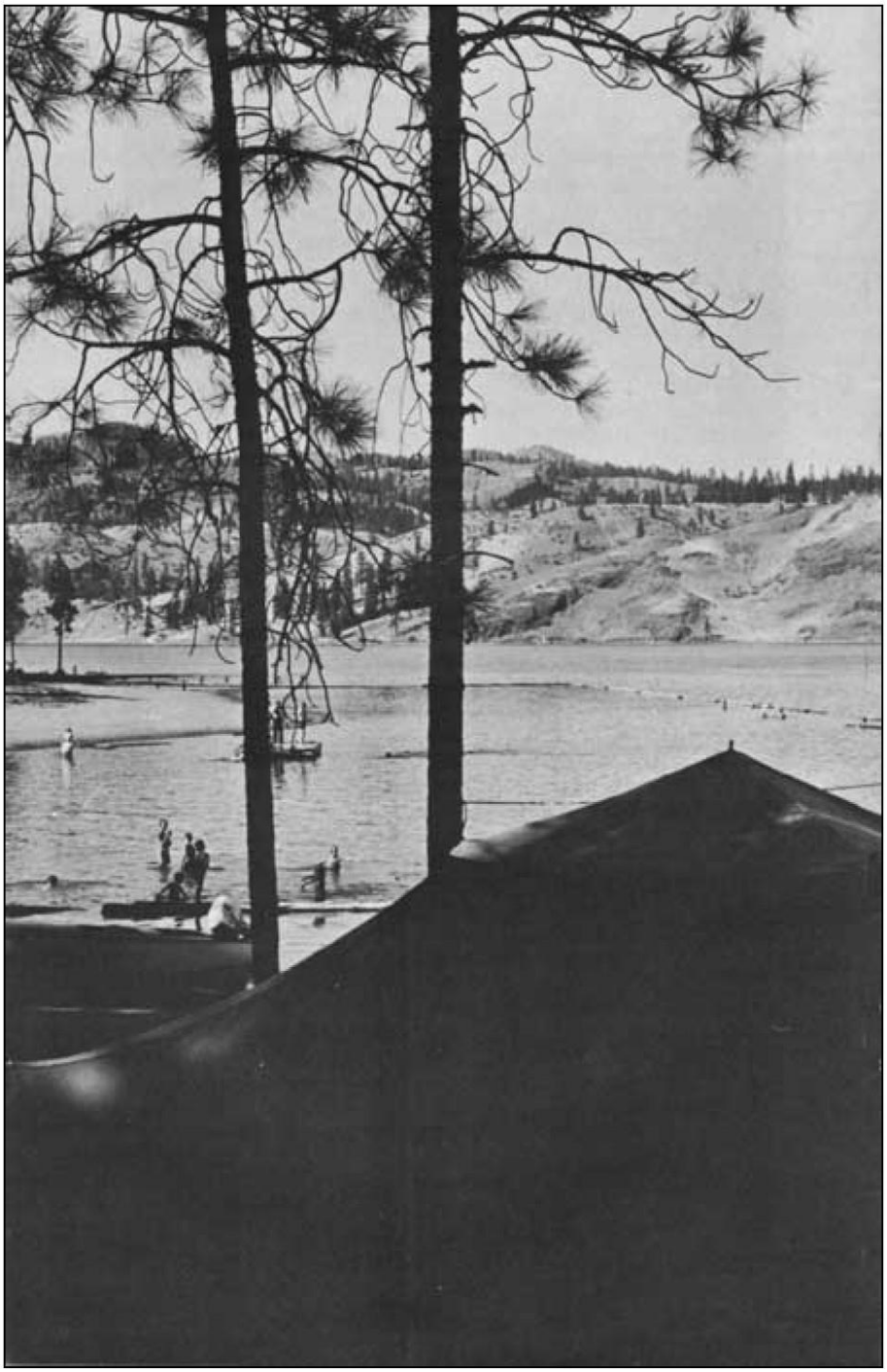
Most of the settlers in the study agreed that the farmer who will be successful on the project must be an adaptable person. Personal characteristics, as outlined by the settlers themselves, were stamina, a willingness to put in long hours and hard work, determination, perseverance, courage, and confidence. Also, they stated that the prospective settler should be willing to learn, to seek advice, and he must keep up to date on farming methods.

Still, in spite of this rather demanding list of virtues, the way of life for the average settler on the Columbia Basin Project is easier than that of the settler in years past on other irrigation projects. Advances in farm methods, wider use of machinery and the automobile, better roads

and communications, and better financial resources of individual settlers are some of the principal changes for the better.

The comforts and conveniences of modern living were not neglected in many of the settlers' homes at the time of this study. More than half of the homes had central or electric heating, and 9 in 10 had running water. All but 2 percent had either a gas or electric range, most being electric ranges because of readily available and economical power Nearly all the homes had a washing machine, and one in four had a clothes dryer. About half had a freezer, and practically all had an automatic refrigerator. The settlers kept well informed, too. At least a quarter of the families had television, and better than 99 percent had a radio; four out of five received at least one daily paper, and more than four out of five subscribed to farm publications and to general magazines.

With some variance, there are many of these average people living and working on project farm units today. Each succeeding year since his arrival on the Columbia Basin Project, this settler has had the satisfaction of seeing his investment in time and money and faith in the irrigated land of the basin pay off. And, as the farmer's lot has improved and his number increases each year as more lands are made available for settlement, the lot of the basin has improved, becoming a better place to work and live and prosper.



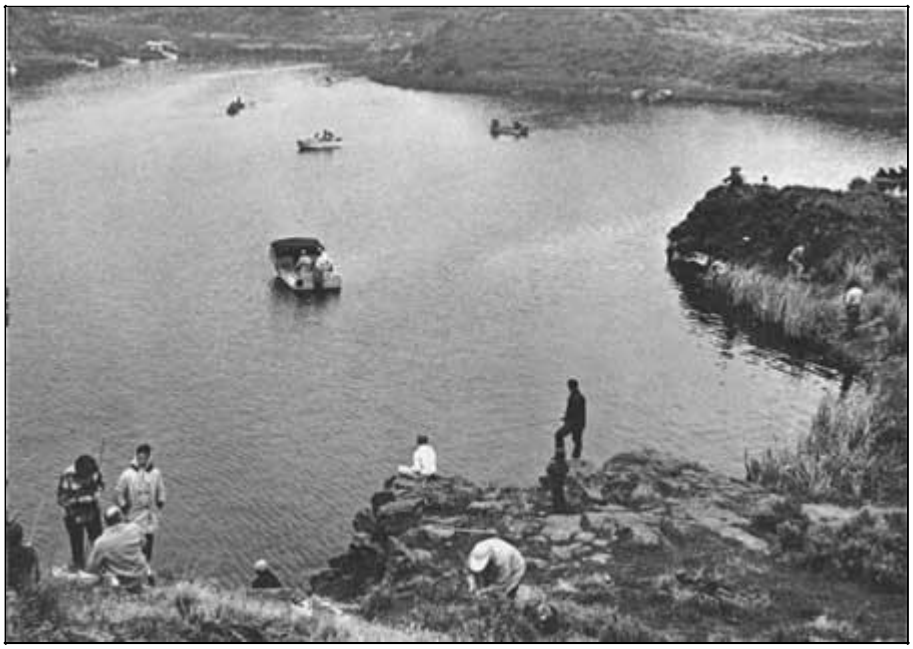
RECREATION IN THE BASIN

Oldtimers say that years ago even jackrabbits carried a canteen to cross the Columbia Basin. In fact, they maintain, if he couldn't carry his own water supply the jack wouldn't make the

trip.

Today, the same rabbit wouldn't bother about a canteen but he might carry a fishing rod or a pair of water skis, because the desert has become a boating, fishing, and water sports mecca. There are almost 500,000 acres of land and water in the project that are open to the public. Where rattlesnakes once sunned themselves, the trout fisherman now takes a limit of scrappy rainbows. Speedboats glide through blue waters 20 feet above a bottom of wind-drifted sand dunes, and children splash and paddle where lizards used to play.

Irrigation water has transformed the desert into a fertile farming region and a prime outdoor recreation and vacation land. Fishing, hunting, camping, and all types of water sports have become an important part of the life and economy of the Columbia Basin.



Corral Lake is one of the many project-created lakes which make up the majority of the more than 100 bodies of water in the Columbia Basin.

On opening day of fishing season, as many as 25,000 fishermen may turn out to try their luck in the lakes of the Columbia Basin Project area. Rainbow trout, silver trout, German browns, crappie, bass, perch, catfish, and ling are some of the fish found in project waters and in fishermen's creels.

However, fishing and water sports are not the only forms of recreation benefiting from the introduction of irrigation water to the area. Family camping has also taken a big upswing in the project. Vacationers who once saw the basin only when passing through, are now spending all or part of their annual holidays in this new sunshiny vacation land.



Franklin D. Roosevelt Lake provides a great many recreation areas such as this one just above Grand Coulee Dam.

The upland game bird hunter finds more game here each year and the area produces some of the best waterfowl shooting in the Northwest. It is not unusual to see 35,000 geese take off at one time from Brook Lake in the Stratford Game Reserve. A regular stop for the big geese on their way south in the fall and on their return trip in the spring, the area also attracts thousands of ducks during their annual migrations. Many thousands of these ducks and some geese have even become "natives," nesting right in the project region.

Mallards, redheads, canvasbacks, ringnecks, ruddies, gadwalls, teals, baldpates, shovelers, sprigs, bluebills, goldeneyes, and wood ducks make use of the abundant lakes, potholes, and seeps on the project. They offer unsurpassed shooting for the water fowlers who pour into the area every hunting season.

In a recent 59-day pheasant season, upland game hunters took a total of 98,750 rooster pheasants in Grant County, an area comprising roughly two- thirds of the project. There are Hungarian partridges in the lowlands, chukars in the scablands and rimrocks, and growing numbers of California and scaled quail, plus some sage hens to round out the bag.

The deer population is also increasing each year and hunters from the basin now range only short distances from home to fill their licenses. Cottontails are increasing rapidly as the amount of cover and feed increases in the irrigated lands. The native jackrabbit population fluctuates, seemingly dependent on the severity of the winters in the uplands and the nonirrigated sections where he makes his home.

But the booming recreation and sports activity of the basin cannot be solely attributed to the project's irrigation water, for in spite of the area's outstanding natural recreation potential, the cooperation of a great many agencies was needed to produce a sound, workable plan to successfully develop the area's recreation features. Working together in the planning, and still working together toward the full development of the area, are the U.S. Bureau of Reclamation, the Soil Conservation Service, the Fish and Wildlife Service, the National Park Service, the Bureau of Outdoor Recreation, the Bureau of Indian Affairs, the State park

department, the State game department, the boards of directors for the three irrigation districts, county and municipal governments, and many other agencies.

In developing the project's recreation potential, a big advantage lay in timing. Recreation sites along lakes which had not yet come into existence were reserved for public use. Regulations were developed to prevent practices that would hurt or limit recreation in the project.



Hunters on the project's Potholes Reservoir near Moses Lake reap a harvest of waterfowl attracted by the many project waterways, seep lakes, and reservoirs.

Today the original 17 lakes in the project area have been joined by a host of new lakes. These lakes rose out of the ground as irrigation water in the area caused the water level in the soil to rise and this higher water table enlarged some of the old lakes, formed new ones, and caused still others to merge into larger bodies of water. There are now over 50,000 surface-acres of water in the Columbia Basin Project area.

As each new lake appeared it was carefully studied and a plan worked out for its development. If the water was deep enough, it was stocked with trout, mostly rainbows. Waters which were infested with rough fish were poisoned and later planted with game fish.

Since irrigation began, the planting of lakes and streams in the Columbia Basin has been stepped up to about 2-1/2 million rainbow trout and silver salmon each year. In addition, a small number of Eastern brook and German brown trout are planted annually. Plantings are not confined to fish, however, for the State game department releases about 2,600 Chinese pheasants and 600—800 chukars, quail, or red-legged partridges each year in the irrigated portions of the basin.

The principal recreational features of the Columbia Basin Project are as scattered and far flung as its irrigation waters. The National Park Service administers one of these features, the Franklin D. Roosevelt Lake area behind Grand Coulee Dam. This lake stretches 151 miles to the Canadian border and offers boating, fishing, swimming, all types of hunting, and scenery ranging from desert to forest and meadow to mountain. There are 34 campgrounds along the lake's shoreline, which are maintained by the Park Service. In 1963 almost 736,000 persons visited this area of water and wooded shoreline.

North of Soap Lake is the 6-mile-long Lake Lenore. Although this lake is somewhat alkaline at present, seepage from irrigation water and pumping from the lower end of the lake is gradually freshening the water. Officials believe it may become a fishing lake by 1966.



Recreation areas on Franklin D. Roosevelt Lake provide facilities for an afternoon picnic or an extended camping trip for the entire family.

Immediately north of Lake Lenore, separated only by a causeway, is Alkali Lake. Formerly highly alkaline, it has freshened since irrigation started and now offers good summer and fine winter trout fishing.

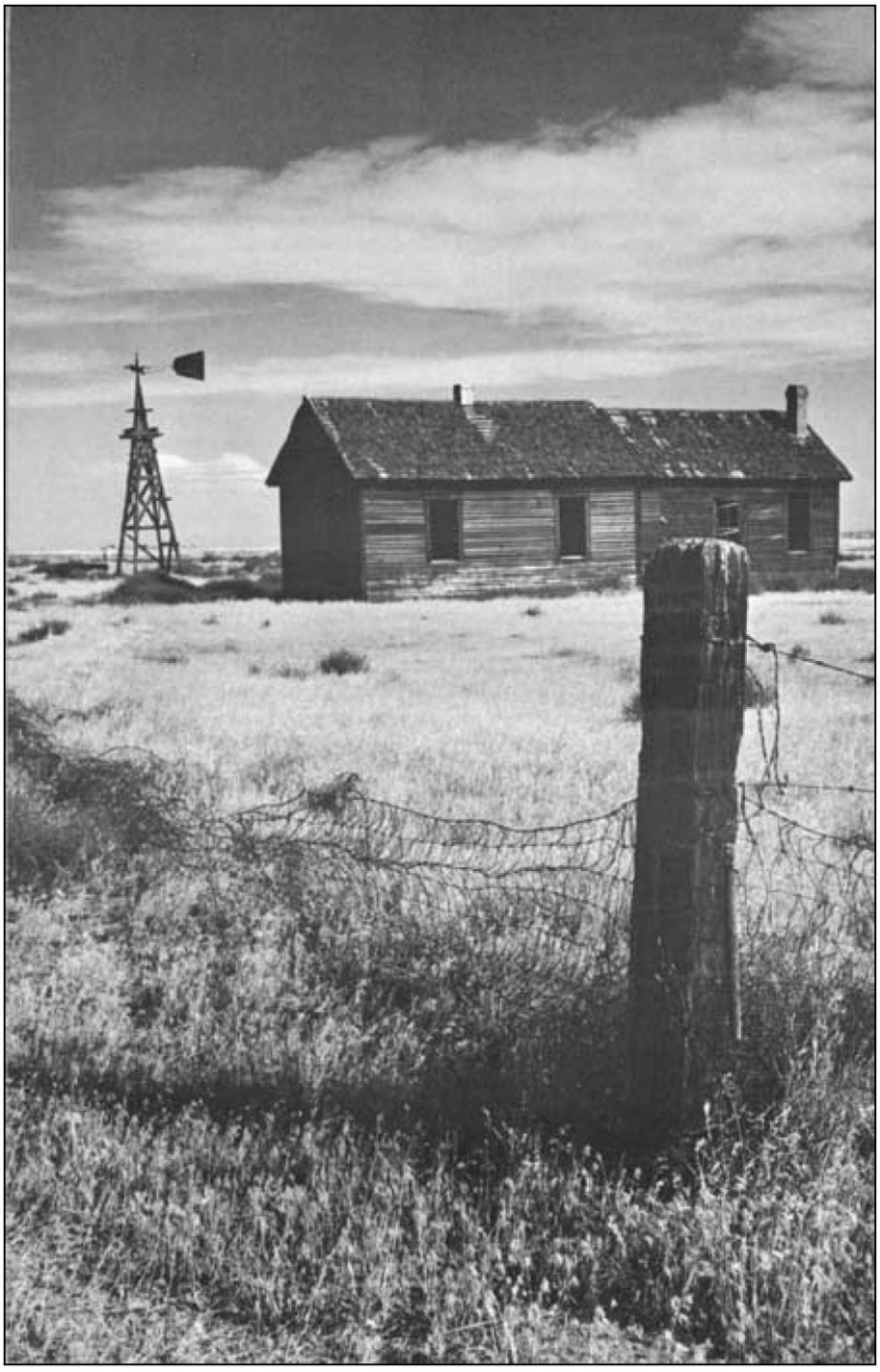
A half mile above Alkali Lake is Blue Lake. It is 3-1/2 miles long and adjoins the southern end of the Sun Lakes Park area. For several years it has been the outstanding lake in the State on opening day of the lake fishing season. On one recent opening day, more than 9,000 fishermen took more than 90,000 trout from its waters. On opening day 1962, despite blustery winds and showers, 2,000 fishermen caught 13,200 rainbow trout at Blue Lake.

The Columbia National Wildlife Refuge, administered by the U.S. Fish and Wildlife Service, is located in the Potholes area. This growing development includes well over 28,000 acres and provides public hunting, fishing, camping, and picnicking areas for thousands of people each year. Acres of marsh and water in the refuge are protected as nesting grounds and planted to food crops for the abundant waterfowl in the area.

From the Canadian border, which marks the upper end of Franklin D. Roosevelt Lake, about 200 miles south to Pasco and covering an area up to 75 miles wide, the Columbia Basin Project has created a grand outdoor recreation area, all wrapped up in a climate of clear desert skies with mild winters and long summers and featuring a maximum of sunshine.

A recreation study conducted in 1958 in the Columbia Basin Project showed that well over a million persons took advantage of the project's recreational benefits that year and spent over $6 million in the area. Obviously the recreational aspects of the project will become even

more important in the future, both to the economy and to the persons enjoying its vast outdoor playgrounds.



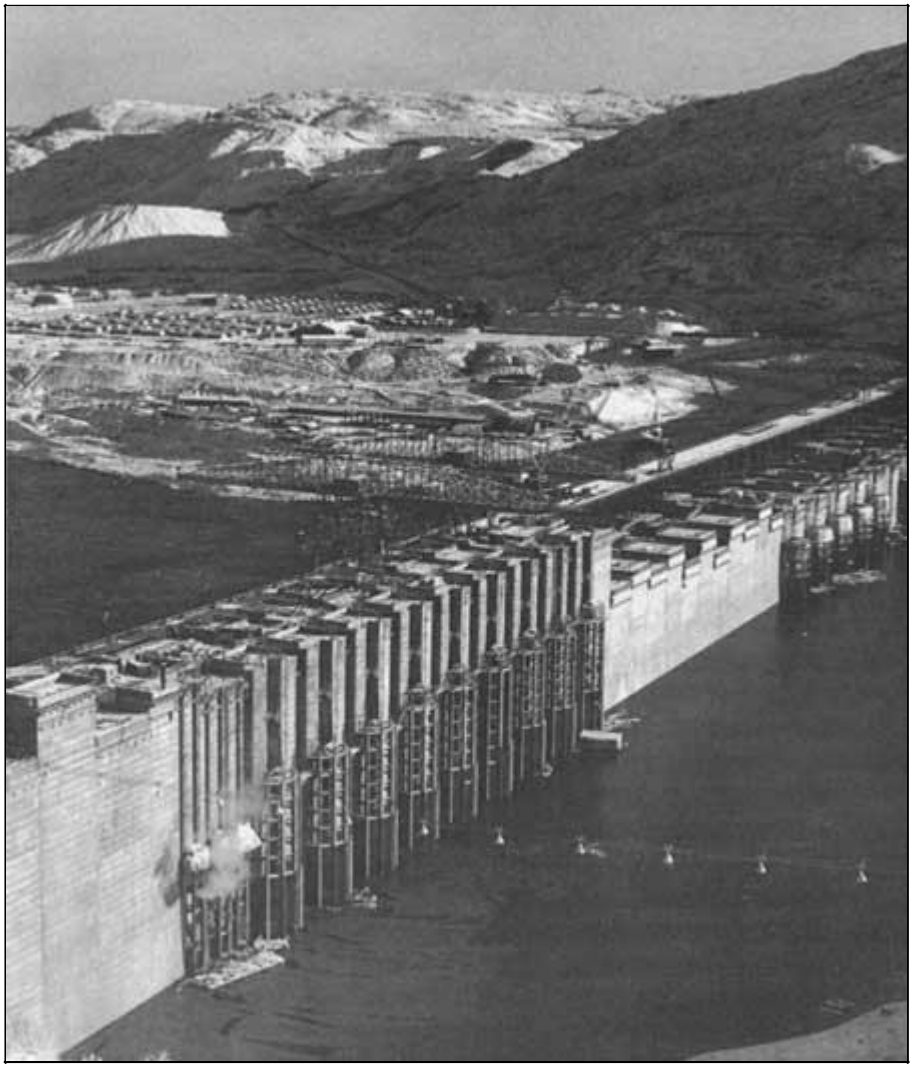
WHAT IT MEANS

When construction of Grand Coulee Dam started in 1933, the Columbia Basin was at its lowest ebb. One rancher, a longtime resident of the area, described it as "being known mostly

for wheat, heat, and rattlesnakes."

In subsequent years, the Columbia Basin Project has turned this land of wheat, heat, and rattlesnakes into a substantial farming area and has provided huge amounts of power for the industries and homes of the Northwest. Foodstuffs and manufactured articles, products of the irrigation water and electric power of the project, go to every corner of the Nation and even to foreign countries.

To better understand just how much of a change there has been in the project area since the days when the construction of a giant dam to provide irrigation water for basin lands was not yet even a dream, you have to go back about 60 years in the history of the area. Until the rush of homesteaders began at the turn of the century, there had been few settlers in the basin and most of the land was used for grazing. Then the homesteaders came and established dryland farms, which for a short time provided them a living. The farmers had to rely on rainfall to grow their crops, but the rainfall often proved to be too scant and most of it came at the wrong time of the year. As they watched the crops wither and die, the farmers began to lose faith in the land that had seemed so promising. By 1910, the exodus out of the basin was growing and in the next 10 years the population dropped 10 percent. The 1920-30 decade saw a further drop of 30 percent as more of the settlers left, joined by townspeople who were forced to quit when business became almost nonexistent.



A little over a year after this picture was taken in 1940 the first small station-service generators began producing power at Grand Coulee.

Fields, once cleared of bunchgrass and sagebrush, became marginal rangeland as the sparse native growth took root in the drifted soil. Searing winds banged the doors of empty houses and turned rusty windmills that could find no water. A few ranchers stayed, gambling that their gaunt herds could find a living on the barren range, but they dared hope for little more than mere existence.

Then, on September 9, 1933, the first stakes were driven for Grand Coulee Dam. Towns were built to house the workers, and a transmission line was snaked across the rough land to bring power to the new towns. Roads and a railroad were built to haul workers and tons of materials. As the cities of Coulee Dam, Mason City, Lone Pine, and Grand Coulee, and at least a half dozen others took shape, workmen who were building the cities were joined by other workmen who would build the dam and operate the businesses, and paint and preach and cook and heal. When cities are born of sagebrush and scabland, they have need of many skills.

The start of construction in the area reversed the steady population decline. At first, the growth was concentrated only in the Grand Coulee area, but when construction of the irrigation system started after World War II, it began to spread southward. As major portions of the irrigation system were completed and construction workers moved on, their places were taken by settlers moving into the soon-to-be-irrigated farms, and by men who filled the towns to operate new and expanding businesses.



Work on the irrigation system of the project got underway after World War II. Here, huge machines pave the Main Canal below Long Lake Reservoir.

The construction boom created by the building of the irrigation system and the settling of farms began to affect the project area of Grant, Adams, and Franklin Counties in about 1950. By 1963, Grant County's population was 49,200, in contrast to 1930's population of 5,562. An increase in school enrollment and facilities went hand in hand with the zooming population. Where there were 2,255 pupils in the project area during the 1926-27 term, there were 21,767 pupils 36 years later. During the last 10 years, school enrollment has almost

tripled, and the value of buildings and equipment has jumped from a modest $5 to $32 million. As school enrollment and population skyrocketed, other phases of living kept pace. The number of telephones in the project area has increased more than 1,000 percent in the last 20 years, and toll calls have increased almost 2,000 percent in the same time. Real estate and personal property tax receipts, which normally lag behind other growth, increased over 300 percent in the 1935-60 period.

Irrigation on the project got underway very modestly in 1948, when a total of 119 acres in Irrigation Block No. 1, just north of Pasco, received water from a pumping plant on the Columbia River. An 80-acre development farm established for experimental purposes by the Bureau of Reclamation near Moses Lake in 1948 was the only other project area under irrigation, with the exception of a few farms in the area that used wells for a source of irrigation water. Beginning with that first 1948 crop year and extending through 1963, farms of the Columbia Basin Project have produced crops worth about $342 million, and the total increases each year as more and more land is irrigated. During the first 15 years of irrigation, the average annual gross return per acre was almost $130.

The Columbia Basin Project area expanded its purchasing power, emerging as a new market hungry for everything from tractors to bobbypins. Created first by money from construction, this market shifted as the basin economy shifted until it is now based principally on an agricultural economy. Gross farm income from crops produced on the project was more than $57 million in 1963, and it will triple that figure as the project develops and more land is irrigated. In addition to the annual gross crop value, the wealth of the area has been enhanced by income from local plants which process farm products from the project. This industry, even younger than the farms of the area, is rapidly expanding to keep up with the growing demand for processed and packaged foodstuffs. And, as this processing industry grows, it increases the demand for even more of these farm products.



Development of the project has meant an echoing development of services and institutions to meet the needs of a steadily increasing population.

One of the largest processing plants in the project area is the Utah & Idaho sugar refinery near Moses Lake, where sugarbeets grown in the basin are processed. A byproduct of the refining process, beet pulp, is used as an excellent feed for project cattle.

There are three frozen-food plants located in the basin, one in Warden and two in Othello. Another, with facilities in Wenatchee, obtains 80 percent or more of its crops for processing from the project area.

Other types of processing plants are springing up as the area proves itself capable of producing a large variety of crops. There are processing plants which make starch from cull

potatoes, plants which prepare peas and asparagus for freezing, and plants that package dry beans for shipment to Mexico and Central America. And there are other plants that sort, grade, pack, warehouse, and ship potatoes and onions.

Peppermint and spearmint oils are extracted from mint crops grown on the project and are shipped to chewing gum and candy manufacturers all over the Nation. Carrots, squash, cantaloups, sweetcorn, tomatoes, watermelons, lima bean, pumpkins, rutabagas, cabbages, and peppers from the area go to the fresh vegetable markets of nearby cities and towns. Project gladioli bulbs are shipped to many parts of the country. The area is well adapted to the production of seed, and it produces, processes, and ships certified seed peas and beans, red clover, Merion bluegrass, alfalfa, Lardino clover, stream bank grass, crested wheat grass, and vetch seeds. Alfalfa hay, one of the leading crops of the irrigated lands, finds a wide market beyond the Cascades on the dairy farms of western Washington. Each season sees more than 50 different crops growing on the project.



With water available, the land has finally been able to realize its potential.

Agricultural experts also predict a large growth in livestock production on the project and believe more and more land will be devoted to corn crops for livestock feeding. With the exception of 1956, each year since the first water came to the land the number of livestock within the project area at inventory time has increased appreciably. Between 1962 and 1963 the number of cattle on the project increased 22 percent, and the rapid growth of the Northwest has created a ready market for the meat produced in the feedlots of the Basin.

Land which offers a maximum amount of frost-free days, a necessity for fruit raising, is found in much of the project's irrigated area, and many land owners are putting part of their farm units into orchards.

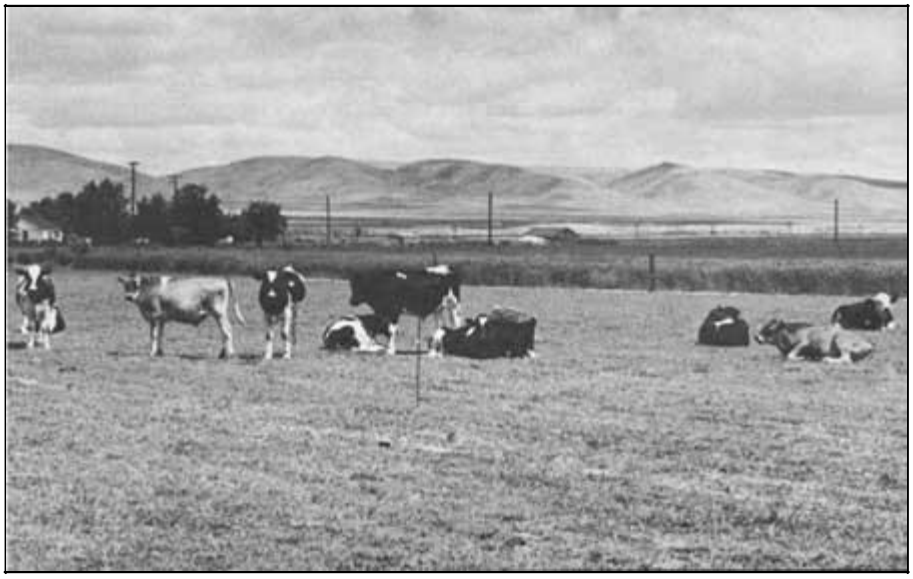


The production of concrete pipe for use on the roads and farmers of the project is an example of an industry attracted to the area by the project's development.



The transportation, sale, and maintenance of farm machinery, manufactured in many States throughout the country, is big business in the Columbia Basin Project.

In the years since the water first came down the canals to the land, the project's thirsty acres have proved that they needed only water and strong, willing hands to become a substantial agricultural area. Project farms have produced a great variety of crops with yields far above the average, and the addition of chemical nutrients and green manure crops to build up organic matter in the soil is continually making project land even more productive.



Basin crops on their way to the markets of the Nation.

In addition to boosting production of foodstuffs, the Columbia Basin Project has brought hydroelectric energy to a power-hungry section of the country, and the generators at Grand Coulee are helping the farmers to pay the cost of the development of project lands for irrigation. Without this revenue from power, development of the project on a reimbursable basis would not have been feasible.

The estimate as of January 1, 1964, of the total cost of the Columbia Basin project, including all construction work yet to be completed, is $969,562,000. Of this amount, approximately $685,000,000 is the cost of the irrigation portion of the project.

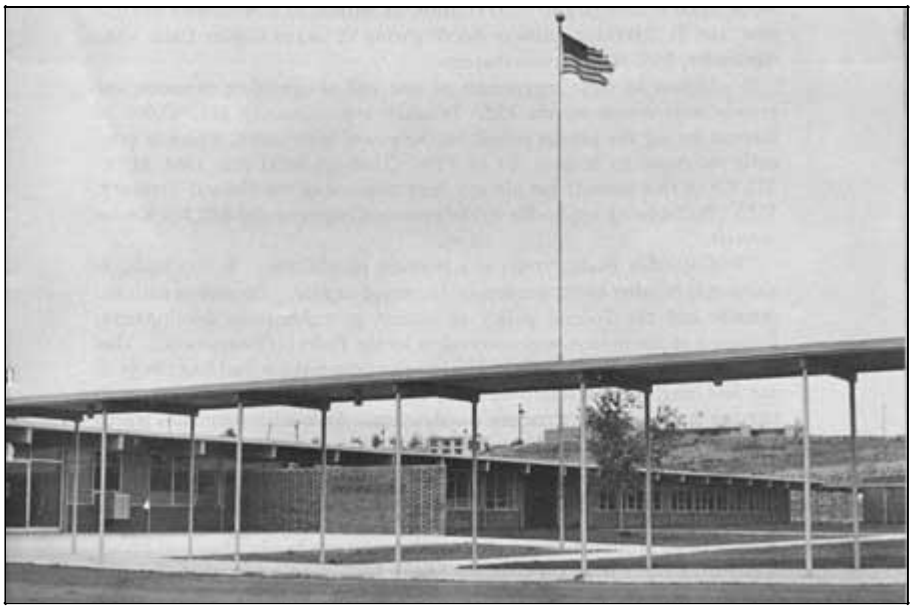
Under present repayment arrangements the money paid by the farmers of the project and power revenues from Grand Coulee Dam will amount to $907,529,000. Land sales to settlers will return an estimated $11,500,000 and the remaining $50,533,000 is nonreimbursable. Of this latter amount, $48,995,000 is allocated to flood control, $1 million to downstream navigation, and $177,000 for spillway floodlighting at Grand Coulee Dam. The remainder, $361,000, is contributions.



Dairy production on the project has been steadily increasing as the settlers' farms develop and the needed capital becomes available.

In addition to these repayments of cost and of operating expenses, the project will return to the U.S. Treasury approximately $81,750,000 in interest during the payout period on the power investment, which is presently estimated to be paid out by 1976. Through fiscal year 1964, $174,321,978 of this amount has already been returned to the Federal Treasury, $116,573,074 being applicable to the principal payment and $57,748,904 for interest.

The Columbia Basin Project is a business proposition. It was built, as thousands of other businesses are, on borrowed capital. Because of national interest and the Federal policy to encourage reclamation development, financing of the project was undertaken by the Federal Government. This financing was made available only after the proposal for building the project had undergone a searching study and was determined to have engineering feasibility and economic justification. Like other businesses which borrow capital, the project must repay the money borrowed from the Government.

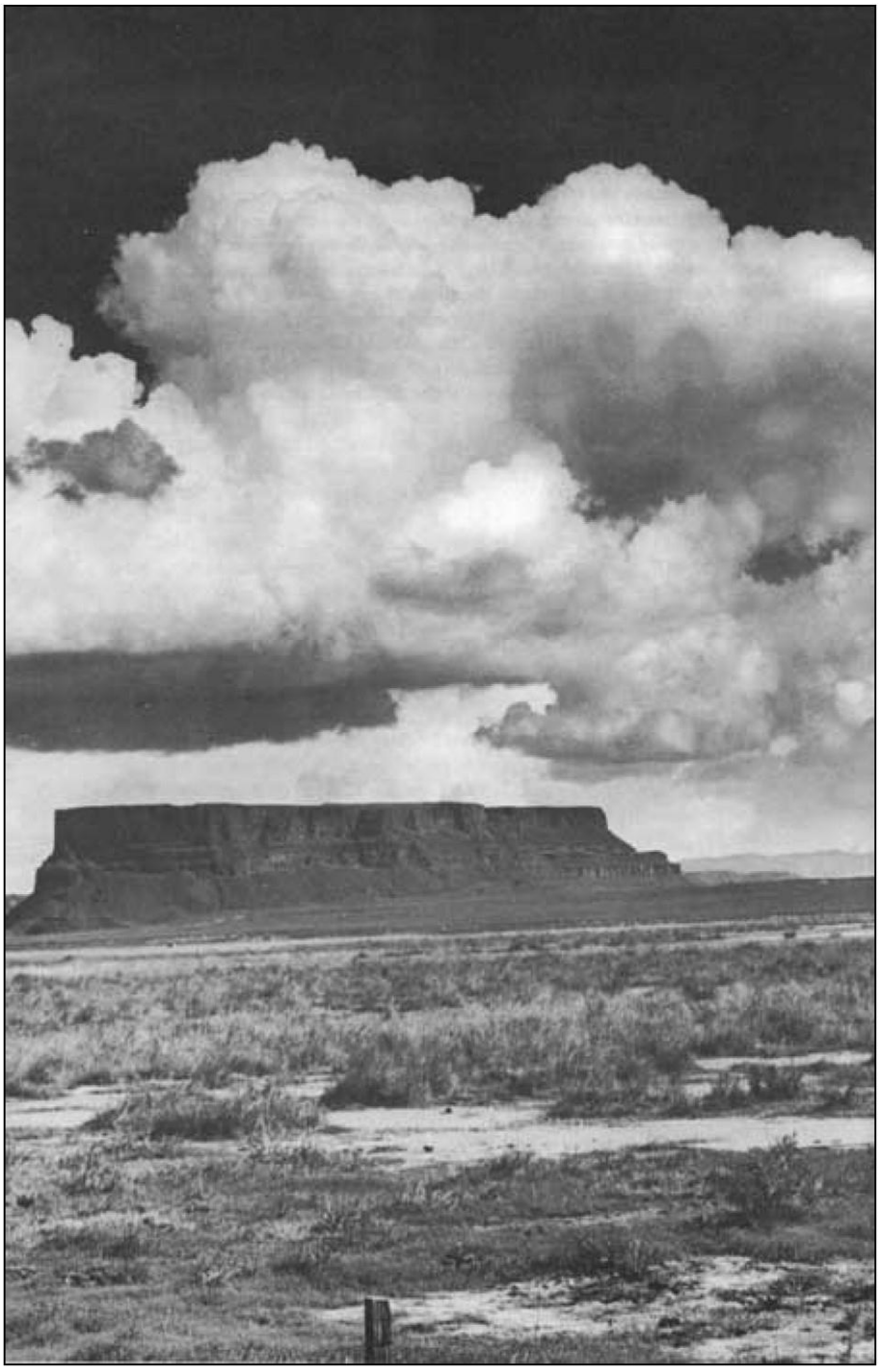


The number of schools and the school enrollment have mushroomed in the project area.

But the Columbia Basin Project is more than a good business investment for our Government and for the people of the Pacific Northwest. The housewife in Moline feels the effect of the project when her husband brings a paycheck home from the farm machinery factory where he works because of orders from the basin and the sales manager in South Bend, Ind., hums a happy tune as more lakes and more fishermen in the basin boost fishing tackle sales for his company.

And there are still more benefits from the project. Although during its early construction years there was definitely more tax money going into the project area in the form of Federal appropriations than was coming out, the picture has now changed. In addition to the cash return from water users and power revenues, there is also a new flow of revenue, represented by the vastly increased tax base. A conservative estimate places the Federal taxes paid on income in the basin at approximately $28 million in 1963. And this is less than one-third the amount that may be anticipated when the project is fully settled. The estimated State and local tax payments in the project area are more than $7 million.

Locally, regionally, and nationally the Columbia Basin Project is more than paying its way.



HOW IT STARTED

Long before the Washington Territory was settled, Indian tribes in the area had made use of irrigation to cultivate fields of potatoes and corn.

On the present site of Ephrata, the Kawachin Indians used irrigation to grow food, obtaining the water from a creek that ran down a canyon into the area from the west.

These same Indians, who were known too as the Moses tribe or the Columbia River Indians, had also farmed on irrigation lands at the mouth of Douglas Creek in Moses Coulee near Palisades. How long those irrigated areas were farmed is problematical, but it is known that they were in existence shortly after the beginning of the 19th century.

With the coming of the white man and his Iron Horse, attention was sharply focused on the problem of obtaining water for the land. With increasingly efficient transportation facilities, there was a mounting demand for water to increase production of agricultural products which now could reach a market.

One of the earliest attempts at irrigation in the Columbia Basin area now served by the project was a joint venture in 1898 of the Great Northern Railway and the Co-operative Irrigation Co. The plan was to bring water from Brook Lake, near Stratford, to irrigate about half a township south and east of Soap Lake, between Ephrata and Stratford.



Homesteaders who settled here at the turn of the century were forced to leave the land when their crops failed.

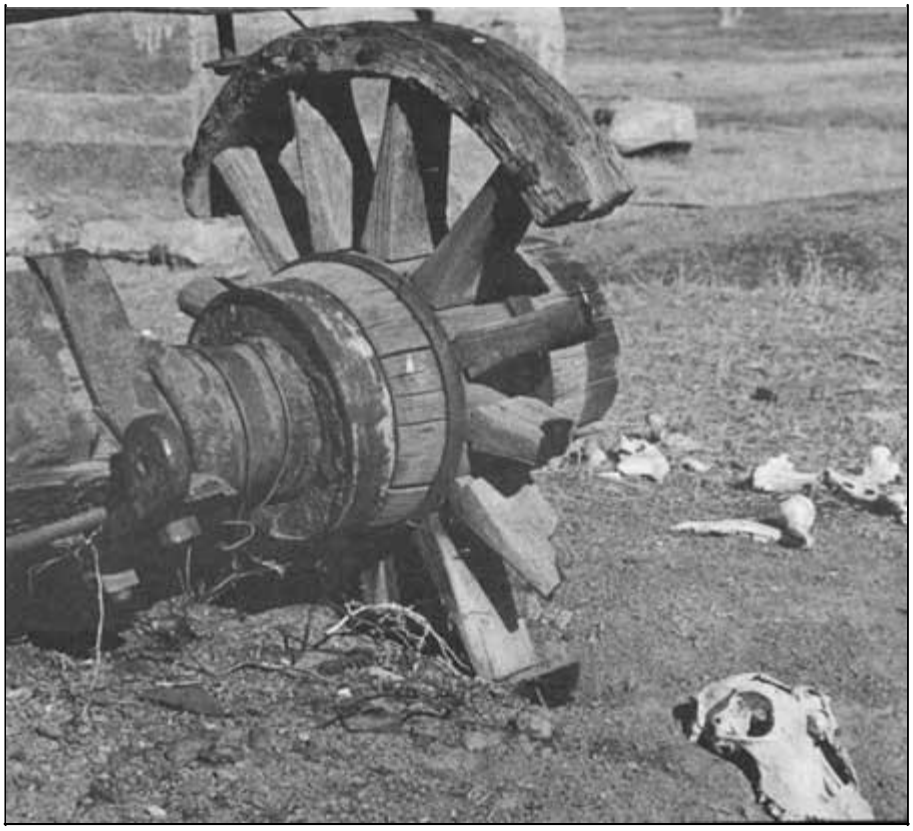
Before the project was finished, however, the company failed and was succeeded by the Adrian Irrigation Co., of Wenatchee. After several years of work, this company also failed to complete the project. The Stratford Irrigation Co., a cooperative organized in Spokane, was finally successful and the first water was delivered to about 1,200 acres of land in 1912. The Stratford Irrigation Co. finally failed in 1918, however, due to a combination of high pumping costs and low produce returns.

Shortly before World War I, a tract of 440 acres was planted to orchard west of Brook Lake and directly north of Stratford. Water was pumped to the land from Round Lake, 3 miles south of the orchard. The trees produced well, but the high pumping cost and a few years of low prices caused the project to fail.

Almost a section of land was planted to orchard in the Winchester area shortly after the turn of the century by a group of settlers from North Dakota. Irrigation was from deep wells drilled on the site of the orchards and pumping was done by gasoline engines. But as the trees matured, the water supply became inadequate. In a desperate attempt to make the water supply stretch, the promoters of the project finally removed every other tree, but the development had to be abandoned. For years, the area was a forest of dead trees, mute witness to another failure.



Another dream, and another failure.



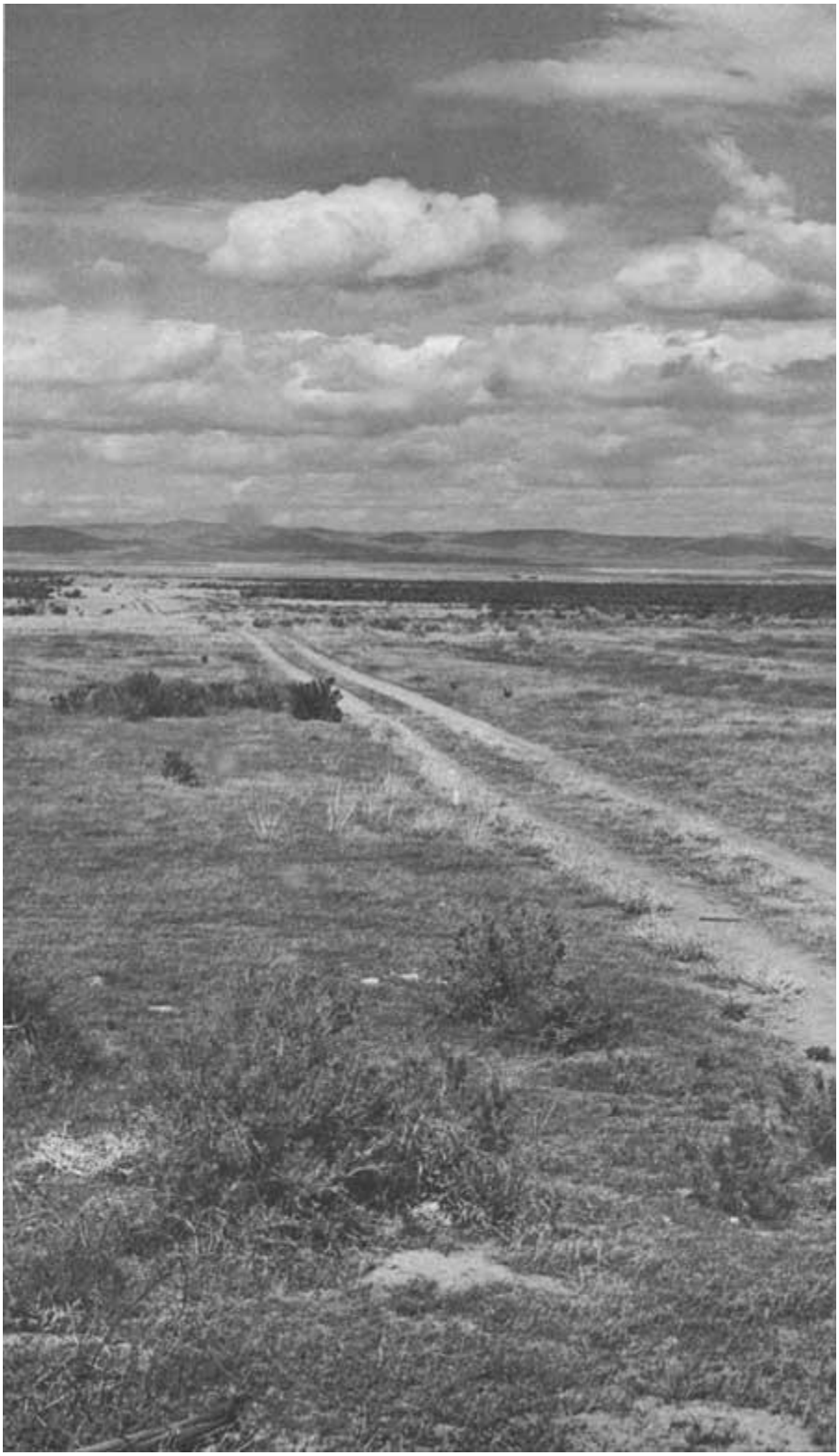
And another.

Henry C. Lewis, a stockman who ran horses and cattle in the region around Moses Lake, recognized the potential water source represented by the lake, and in 1900 filed a homestead in what is now the Cascade Valley. He proved his homestead by 1906 and sold out to Charles Tichacek, a Bohemian experienced in orchard and vineyard culture. Tichacek planted about 6 acres of vineyards and 10-15 acres of orchard, which he irrigated from the lake by pumping the water with a steamplant fired with coal hauled from the railroad at Ephrata. In the next 6 years, several other small pumping plants were built along the shores of the lake as more homesteaders turned to irrigation with Moses Lake water.

In 1907, the Quincy Valley Water Users Association was formed. This organization proposed assessing its members and securing other financial help to pay for reclamation studies of the Quincy Valley. Joseph Jacobs, Seattle consulting engineer, made a study of the possibility of bringing water from Lake Wenatchee to irrigate the valley. The results were encouraging enough to prompt the association to form the Quincy Valley Irrigation District in 1910. The new district proposed that the State of Washington be bonded for $40 million to irrigate 400,000 to 500,000 acres in the Quincy Valley. But in a general election voters of the State rejected the proposal and, while the district continued to work for the adoption of the plan, there was little tangible progress in succeeding years.

A novel experiment in pumping water from the Columbia was attempted in 1907 when Willard H. Babcock, operating the land on what is now known as Babcock Ridge overlooking Trinidad, built six windmills on the side of the cliffs above the river. His intention was to pump drinking water up the hill to his cattle with the windmills, but his operation was watched by others who saw the possibility of furnishing irrigation water to the land by this method if it proved successful. It is probable that Babcock's plan would have actually worked if the pumpline had been built with a reservoir at the top of each lift so each windmill could have pumped independently. However, without these reservoirs the successful operation of

the system called for pumping by all of the windmills at the same time. But the wind proved to be fickle, turning some of the mills fast, some slow, and even allowing one of them to stop occasionally. After several attempts to modify and adapt the system, Babcock was finally forced to abandon it.



Before irrigation—sparse desert vegetation and a faint road running across the prairies like a hint of hope.

People in the lower reaches of the Columbia Basin were not without their dreams and schemes for irrigation either. From Vantage south along the river, the topography lends itself more to the pumping of water from the river and this advantage was quickly noted by early settlers. At Beverly in 1908, a company attempted to irrigate about 500 acres of land in that area by using a coal-fired pumping plant. Operations had to be halted after a year of work had shown the cost of irrigating the land to be $15 to $20 an acre, too high for profitable operation in those days.

Near Corfu, at the foot of the Saddle Mountain range, a company composed mainly of railroad men put in some irrigated orchards and farms from about 1905 to 1907. Water for irrigation came from Goose Lake, north of the site, through a gravity canal. A dam-and-gate system was built at the lake to conserve the water that poured into the lake when the inflowing Lower Crab Creek was high from the spring runoff. This operation was continued for several years with some success until breaks in the canal, falling farm prices, and a couple of bad crop years made it too costly.

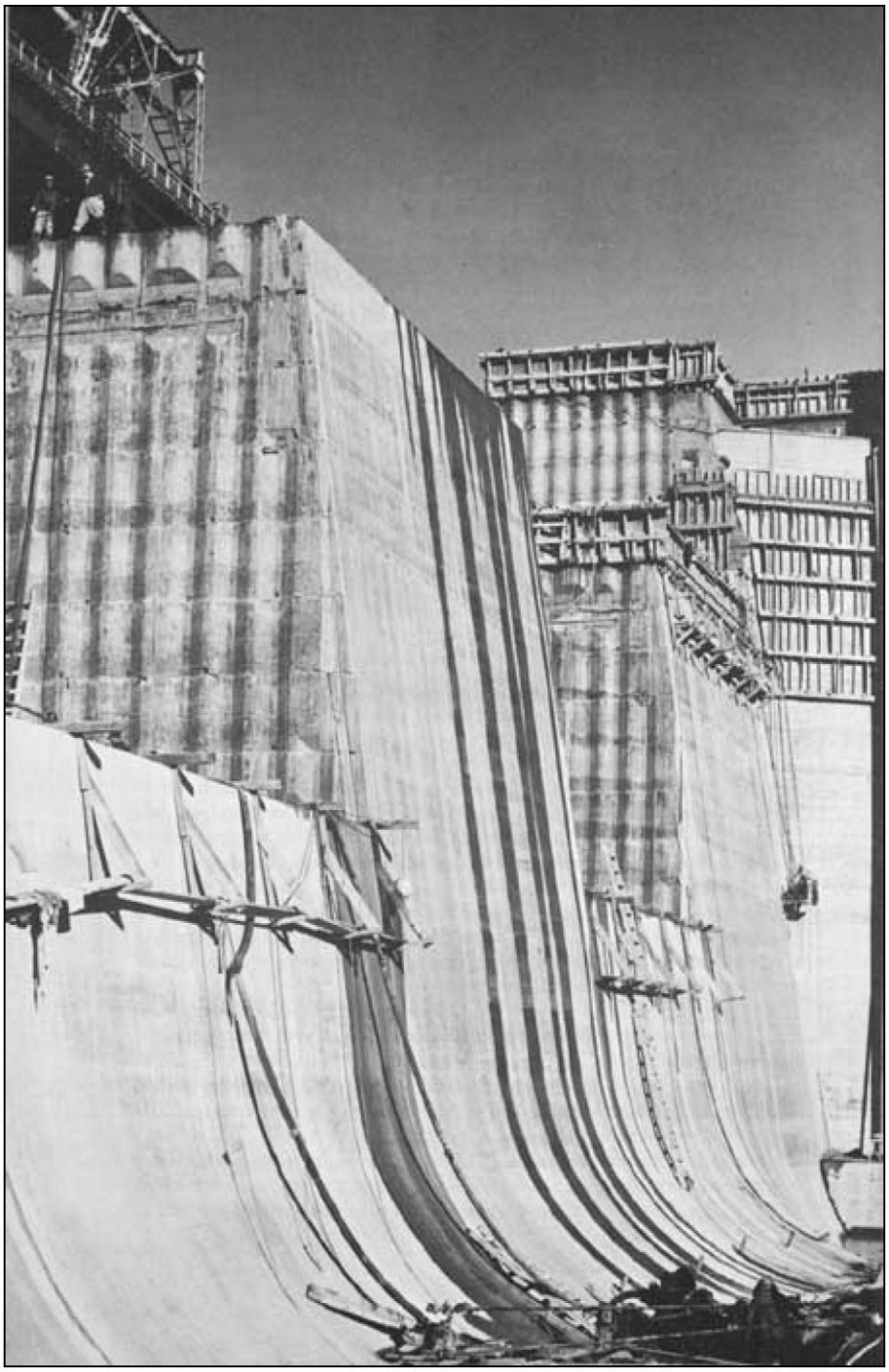
In 1909, a company known as Delarm and Biehl began an ambitious irrigation project on the Wahluke Slope. Their plan was to pump from the Columbia at a point about halfway between Priest Rapids and the town of Wahluke into a canal which would run in a semicircle and finally return to the river at Wahluke. The project was financed by the sale of bonds and the bonds were backed by mortgages of about $100 an acre from the homesteaders who had filed desert claims on the lands.



The sand dunes in the center of the project were pretty at times, but not very productive. Much of this area is now covered by the waters of the Potholes Reservoir.

A pumphouse, equipped with gasoline engines and the latest and best pumping machinery, was built on the bank of the river and an unlined canal was gouged out of the sagebrush. However, no water was ever pumped and the company was declared bankrupt in 1912. One of the promoters disappeared and a body identified as the other was pulled from the Columbia River not far from the site of the pumphouse. More than a million dollars from the sale of bonds disappeared also.

Several other irrigation ventures were attempted along the lower reaches of the river by small companies or individuals, but none of them were successful enough to warrant continuing operations. The high cost of initial investment and operation was apparently more than a small operation could stand. What was needed was a large-scale irrigation project that could spread the cost over hundreds of thousands of acres and also bring in other revenues from the river's resources to make the project economically sound. What was needed was a multipurpose project.



HOW IT DEVELOPED

On a hot July day in 1918 in Ephrata, Rufus Woods, publisher of the *Wenatchee World,* stopped by the Grant County Title & Abstract Co. in search of news. Woods, a

newspaperman who believed in personally covering the area served by his paper, was on his regular newsgathering beat. W. Gale Matthews, operator of the title company, passed the time of the day with his visitor and then said, "I'm a little busy right now, but if you want news, I suggest you go over and see Billy Clapp. He can put you on the track of a story which deserves some study and could be the biggest thing you've ever written".

It was only a few steps across the street to the office of William M. Clapp, a local attorney. A few minutes later, Woods was alternately listening and asking questions as Clapp outlined a plan to utilize the Grand Coulee as a waterway to irrigate the land of the Central Columbia Basin. Pointing out that the Grand Coulee had originally been formed when the Columbia River was blocked by a glacier, Clapp suggested that a concrete dam could as effectively block the stream and raise the level of the water to where it could once more be diverted down through Grand Coulee.

The idea was not completely new to the area. People who lived in the vicinity of Grand Coulee had talked about it for years, but the idea had never progressed beyond the stage of discussion. Clapp was probably the first to advance the idea backed by any kind of engineering investigation.



This is the site of Grand Coulee Dam as it looked before the first contract for its construction was let on July 13, 1934.

It was first broached to Clapp early in the summer of 1917, when a group of local men were sitting in his office discussing World War I and the talk turned to the production of food. There was a discussion of the potential food value of the basin if water could be put on the land. Someone then suggested that the water for the basin might come from the Columbia River at Grand Coulee. The random remark piqued the men's interest.

In the fall, after several more sessions of talk, Clapp and the others took Norval Enger, a deputy county engineer of Grant County, into their confidence. The group later appeared before the board of county commissioners and asked it to authorize a survey of the proposed area. The commissioners were not enthusiastic about the wild-sounding scheme but consented to a survey provided nothing was said publicly about it.

Enger looked over the general situation during the winter of 1917-18 and ran a set of levels on the river and the coulee. He reported to the commissioners, and to the group requesting the survey, that the plan seemed to have merit but would require a great deal more study. He admitted that the total costs of such a project would certainly be far beyond the financial resources of the county—but the project appeared to be feasible.



This is the dam as it looked in late 1936 from the river's east bank. Trestles in the left foreground mark the present line of the dam. The area is enclosed by a cofferdam and the river is flowing through the partially completed section of the dam in the upper right of the picture.

On July 18, 1918, the *Wenatchee World* published the story as outlined by Clapp and written by Woods. It was headlined:

FORMULATE BRAND NEW IDEA FOR IRRIGATION GRANT, ADAMS, FRANKLIN COUNTIES, COVERING MILLION ACRES OR MORE

Last and Newest and Most Ambitious Idea Contemplates Turning of Columbia River Back into Its Old Bed in Grand Coulee, the Development of a Power Plant Equal to Niagara and the Construction of the Greatest Irrigation Project in the World—First Conceived by William Clapp of Ephrata, Wash.

A few months after the *Wenatchee World* printed the story of Billy Clapp's proposal to irrigate the Columbia Basin by building a dam across the Columbia River, a radically different plan to achieve the same purpose was proposed by the chairman of the State Public Service Commission, E. F. Blaine.

Blaine had lived in the Yakima Valley for years and was familiar with irrigation. His plan was to transport water to the basin in a gravity-waterway system from Pend Oreille Lake in Idaho, a distance of about 130 miles. He proposed a dam be built across the Pend Oreille River in the vicinity of Albeni Falls in Idaho, near Newport, Wash. The main waterway was to be a succession of canals, natural waterways, viaducts, and siphons terminating in a reservoir near Ritzville, just outside the eastern edge of the present project area. From this reservoir, the water was to be distributed to the basin lands.

Both proposals for irrigating the basin lands had their own group of backers. But, in addition to the opposition each plan found in the adherents of the other group, there was opposition from others who feared that the cultivation of the basin land would wreck the price structure of farm products and others who opposed both plans because of their high cost.

In 1919, the Washington Legislature created the Columbia Basin Commission and appropriated $100,000 to be used in making a study of the two irrigation plans. The report issued by the commission favored the gravity waterway method.

In 1921, however, a Seattle engineer, Willis T. Batcheller, released a report favoring a dam at Grand Coulee after making a study of both proposals. Then Maj. Gen. George W. Goethals, who had built the Panama Canal, was retained by the Columbia Basin Commission to make a study of the situation. After studying the basin and maps and reports on both plans, the general submitted a report March 30, 1922, favoring the gravity method, saying it would be simpler and cheaper to build. First the one plan and then the other momentarily appeared triumphant.



Grand Coulee Dam as seen from Crown Point. The city of Coulee Dam appears in the right foreground.

James O'Sullivan, a native of Port Huron, Mich., was one of the chief figures in this seesaw battle who spearheaded the fight to build the dam at Grand Coulee. O'Sullivan came to the basin to buy an irrigated farm on the shores of Moses Lake and remained to practice law instead. In addition to being a lawyer, O'Sullivan had been a contractor in Port Huron, where he operated the family's construction business for several years. His personal investigation of the site of the proposed dam and his knowledge of engineering convinced him the dam was feasible, and he spent all his time and efforts in pushing the Grand Coulee plan, working without pay and forsaking his law practice. For O'Sullivan, the fight for Grand Coulee became a way of life.

The turning point in the struggle came through the bipartisan efforts of two Washington State

Senators, Republican Wesley L. Jones and Democrat Clarence C. Dill. Together, they tried to secure an appropriation of $600,000 during the 1926 session for a comprehensive study of the two different schemes of irrigation, but they were unable to get the support of Congress. However, Senator Jones, a senior member of the Commerce and Appropriations Committee, inserted the appropriation in a rivers and harbors bill where it was undetected by the opposition. The appropriation called for a study of the Columbia River, but mentioned neither Grand Coulee Dam nor the gravity plan.

The measure passed and Maj. John S. Butler of the Army Engineers was directed to make the survey. The work started in 1928 and was completed in 1931 at a cost of $316,441. In his report to the House Committee on Irrigation and Reclamation, Major Butler said, in part, " The gravity plan is not economically feasible because of excessive costs.... The pumping plan of placing water on the project is altogether feasible, both from an economic and an engineering viewpoint . . . ."

Proponents of the dam, led by O'Sullivan, began working for the dam all the harder. In fact, the residents in and around the town of Ephrata worked so hard and became so conversant about various aspects of the proposed project that the whole community was labeled "the dam university." Major opposition developed from private utilities, who proposed a low-head power dam at the Kettle Falls site.

In an ironic way Mother Nature even lent a helping hand. During the winter of 1929-30 the Pacific Northwest experienced a crippling power shortage as a result of a drought that robbed the comparatively small streams of the Puget Sound of their power. The "dam university" was not slow in pointing out that the source of the proposed Grand Coulee Dam's power was the Canadian icefields, impervious to drought.

In April 1931, passengers aboard an ocean liner 600 miles off the coast of Seattle heading for Honolulu were suddenly engulfed in a huge cloud of fine dust. The cloud was estimated to extend from about 300 miles east of Portland to 1,000 miles out to sea. This was the topsoil of the Pacific Northwest. The best way to stop this mass exodus of sorely needed land? Irrigation—irrigation such as the Grand Coulee Dam could provide to feed the millions of grasping roots which would hold the land down.

But Congress still had little stomach for this expensive irrigation project in the remote Northwest. The country was engulfed in what appeared to be a bottomless depression. In a special message to Congress in February of 1932, President Hoover said: "We do not need further additions to our agricultural lands at present. Additional agricultural production, except such marginal expansion as present projects warrant, is inadvisable."

One year later, however, a presidential candidate by the name of Franklin D. Roosevelt outlined to newsmen a bold plan to strike at the heart of another serious problem facing the Nation, unemployment. The plan called for a broad development program of the Nation's resources with the primary purpose of providing jobs. True to the precampaign speeches, a few weeks after election President Roosevelt included Grand Coulee Dam in his new Public Works Administration Program.

The State of Washington allotted $377,000 for preliminary work at the damsite and the job of building a dam at Grand Coulee was handed to the Bureau of Reclamation. The late Frank A. Banks, who had headed dam construction on several other Reclamation projects, was named construction engineer in charge of the work. Temporary quarters for a skeleton force of engineers was set up at Almira until a town could be built at the damsite.



With the dam completed, work began in earnest on the many miles of waterways needed to transport the water to the land.

On September 9, 1933, Frank Banks, Clarence Cole, Althe Thomas, Fred Berry, Ceylon Rossman, and Harold Sheerer drove the stakes for the axis of the dam. A few months later, clearing of the site and removal of soil and gravel deposits to reach foundation rock got underway.

When the Grand Coulee Dam was first proposed, investigations established the height of the dam at about 350 feet above river level. This was high enough to allow pumping of water for irrigation and was low enough to prevent backing water into Canada. During the 15 years from the first proposal of the idea to the start of construction, the concept of a high dam capable of providing irrigation water was never abandoned. However, when President Roosevelt gave his approval to the idea of a dam at Grand Coulee, in order to save money he suggested building a low dam at a cost of about $63 million with the possibility of adding more height to the dam later.

Backers of the irrigation plan were bitterly disappointed. A low dam would be capable of generating electricity, but the basin still would have no water. On July 13, 1934, the contract to build the low dam was awarded to the MWAK Co. for $29,339,301. MWAK was a merger of several different firms, the principal companies of which were the Silas Mason Construction Co., the Walsh Construction Co., and the Atkinson-Kier Co. Building even the low dam at Grand Coulee was too big a job for any one contractor.

Four days after this contract was awarded, a contract was awarded to David K. Ryan to build 32 miles of railroad to the damsite from a connection with the Northern Pacific line near Coulee City. The line ran from Odair to the damsite at the bottom of what is now Banks Lake and was operated by the contractors to haul materials and equipment. The line was built in a year. During this same period, the State highway department spent more than $600,000 on roads and bridges in the general area of the dam.

Almost a year after the contract for the low dam was let, the backers of Grand Coulee Dam had reason to celebrate. A change order was approved allowing construction of the high dam. In January 1938, MWAK finished its contract and, less than a month later, Consolidated Builders, Inc., a joint venture formed by MWAK and several other construction companies, was given a contract to finish the high dam for a bid of $34,442,240.

The dam was built in steps, with the flow of the river being juggled back and forth in its channel as work progressed. The first section of the dam was built on the west river bank, while a cofferdam diverted the river and channeled the water along the east bank. This cofferdam enclosed about 60 acres, which was excavated to bedrock and then cleaned and grouted to make a firm foundation for the dam. Concrete was then poured in the area until it was above low water level. After the west portion had been built up, the cofferdam was opened to allow the water to pass through on that side. Across the river, cofferdams on the east side were closed and the operation was repeated.

Then the workmen ran into a problem—wet clay on the east bank slipped down faster than it could be removed. After retaining walls and several other plans had failed to stop the sliding mass, one of the younger engineers suggested freezing the problem area. A refrigeration plant was built and miles of ammonia pipes were buried in the toe of the slide. The ice dam held back the clay and the work continued. On May 25, 1939, a world's record was set when 41,900 tons of concrete were poured in 24 hours onto the growing gigantic mass that was to be Grand Coulee Dam.

Although Grand Coulee Dam is now a solid mass of concrete, it was built as a group of interlocking columns, varying in size from 50 feet square to 25 by 44 feet. These columns were built up 5 feet at a time, with 72-hour intervals between pourings. Because concrete shrinks as it cools, the joints between these columns could not be filled with grout or liquid concrete to make the dam solid until the temperature of the individual columns had cooled. Engineers estimated it would take several hundred years to cool the concrete at the normal rate, so pipes were embedded in the concrete as it was poured and river water was pumped through them to cool the structure. The concrete cooled in a matter of months and the joints and pipes were then filled with grout. About 1,700 miles of this pipe is buried in the dam today.

As Grand Coulee Dam neared completion, World War II erupted. The United States was soon frantically building weapons for its own defense and for countries soon to be its allies. The demand for power outstripped all available supply and Grand Coulee Dam became the center of attention as a potential source of electrical power.

On March 22, 1941, the dam's two small station service generators were put into operation. Even these units could not operate at full capacity, however, because there was not enough water behind the dam, but they put out as much as possible—about 14,000 horsepower, or nearly 11,000 kilowatts. On October 4, 1941, the first of the 108,000-kilowatt generators was put into service. Five more generators were rushed to completion, and two more, scheduled to be installed in Shasta Dam in California, were shifted temporarily to Grand Coulee. This immense amount of available power later made the Hanford atomic installation possible at Richland, which proved to be a great factor in the manufacture of atomic products and helped bring an end to World War II.

The demand for power continued after the war as Northwest industry expanded. The last of the dam's 18 generators went into service September 14, 1951. This made the powerplant of Grand Coulee the largest in the Western Hemisphere, a position it still holds, with an installed capacity of 1,974,000 kilowatts. However, the actual output is quite often greater than that. The plant has an hourly output record of 2,324,000 kilowatts (September 9, 1953, 9-10 a.m.).

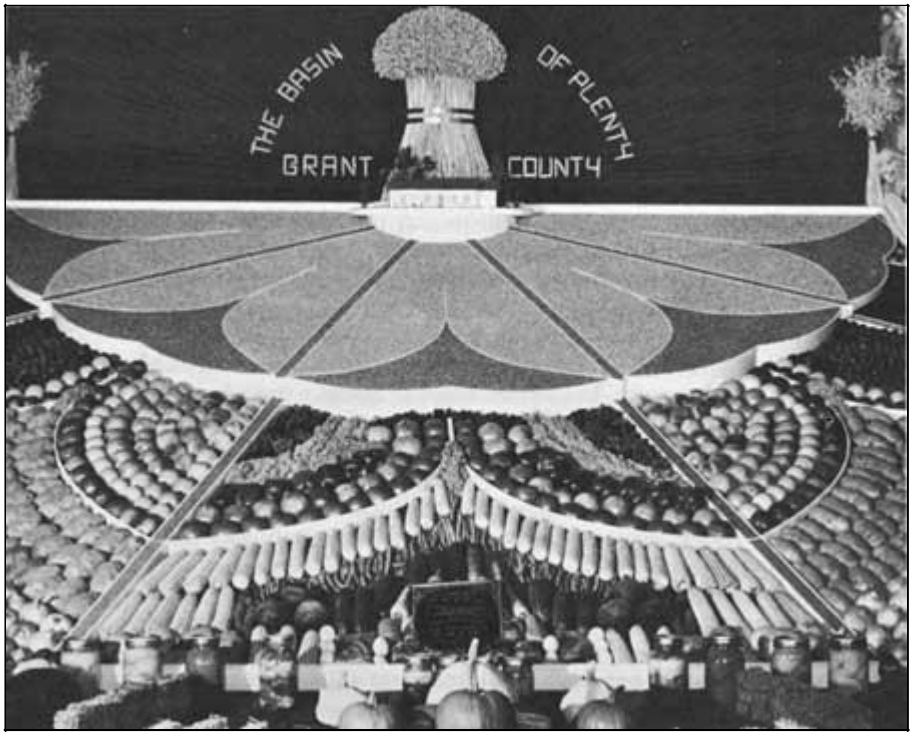
After the war, the emphasis at the dam shifted from power production to its primary purpose, the irrigation of land. Work began on the pumping plant at Grand Coulee and contractors were soon building tunnels, siphons, storage dams, and canals throughout the Columbia Basin Project area. The land was classified and appraised, the soil tested, and the whole area

was laid out in farms and irrigation blocks. More than 4,000 topographic maps were drawn, one for each square mile of land, and the force handling land classification took 45,000 soil borings and performed more than 15,000 soil analyses and tests. The land classification was finished in August 1941.

Now the project area was divided into irrigable and nonirrigable lands. Land suitable for irrigation was divided into three classes, according to how well it would produce under irrigation. Class 1 land was the best. It was smooth, gently sloping, deep and fertile soil, adaptable to a wide range of crops and free of alkali and rocks. Class 2 was average land, good for farming, but not as good as Class 1. Class 3 included land which could be farmed by irrigation, but was restricted in the kind of crops it would grow and was expected to give poorer yields than the other lands.

After the land had been tested and classified, it was appraised. The value of the land was determined by a board of three men well versed in land values in the basin. The land value was based on how much the land was worth as a dryland farm.

Finally the land was ready. All that was needed was the completion of the main system of waterways to bring the final important ingredient, irrigation water. On August 10, 1951, the first test water flowed into the main canal from Banks Lake toward the waiting Columbia Basin farmland.



In conclusion—a county fair with a display of basin crops.

The subsequent development of project lands was a slow, steady process with water coming to more of the land each year. This gradual development made it easier for the area and the irrigation system to accommodate more farms and for markets to absorb the increased production. This gradual development and growth of the project is still continuing.

The Columbia Basin Project was planned as a family-type development, designed to provide a farm which would yield a living for one family. Under the original project law, ownership by any one family was limited to one farm unit, or a maximum of 160 acres of irrigable land.

As amended in 1957, the law allowed, each adult in the family to own and receive water for up to 160 acres of irrigable land. However, a new amendment, enacted on October 1, 1962, entitles all landowners to water for 160 irrigable acres or 320 irrigable acres for a husband and wife regardless of when the land was acquired.

The average farm unit on the project is presently about 85 irrigable acres, depending on the quality of the land. Those farms with the better land are smaller than those with poorer land. In this way each farm's potential income is adequate to support a suitable standard of living.

The purchaser of a Reclamation farm unit signs a recordable contract in which he agrees to pay part of the construction costs of the irrigation system. Payments are based on the project farmers' ability to pay. The average repayment of $85 per acre was established in the original repayment contracts on October 9, 1945. Construction costs were to be repaid over a 40-year period and averaged $2.12 an acre per year.

In 1962 and early 1963 the farmers in the three irrigation districts which the water users of the project had formed voted to accept a revised repayment contract negotiated with the Bureau of Reclamation which increased the repayment costs to an average of $131.60 per acre, and lengthened the repayment period to 50 years. The new repayment contract will permit all of the project drainage construction costs to be included in the construction repayment arrangement instead of being paid separately each year while the drains are being built.

Under the revised repayment contract with the project's three irrigation districts, the construction charges per acre will be rather small during the early years following the development period, and gradually increase in succeeding years in such a manner that full repayment will be accomplished in 50 years. Water rental charges, which pay operation and maintenance expenses of the water delivery system, are also based upon the repayment ability of the various classes of land on the project.

Under the new amended repayment contract, the first water users in the Columbia Basin Project will repay their construction charges by the year 2010, almost a century after the idea for the project was conceived. But the costs of the Columbia Basin Project cannot be tallied entirely in terms of money. For many who stood and watched the first trickle of water flow to the south from Banks Lake in 1951 could remember the early days when they fought what seemed to be an almost hopeless battle. Perhaps they thought of the disappointments and the bitterness, of the small battles won, and of the constant and exacting hard work required to win this victory.

Regardless of the yardstick used to measure and appraise it, the project has already proved itself more than worth all costs of all kinds. Where nature had decreed a desert, man has made a prosperous land complete with power, water, and people.

TOURING THE COLUMBIA BASIN PROJECT

Visitors to the Columbia Basin Project are always welcome. For their convenience a tour center is located adjacent to the project's largest multipurpose structure, Grand Coulee Dam. The center offers lectures on the construction of the dam and a taped pictorial presentation of the irrigation project, as well as restroom facilities, a lounge, and an unobstructed view of the dam.

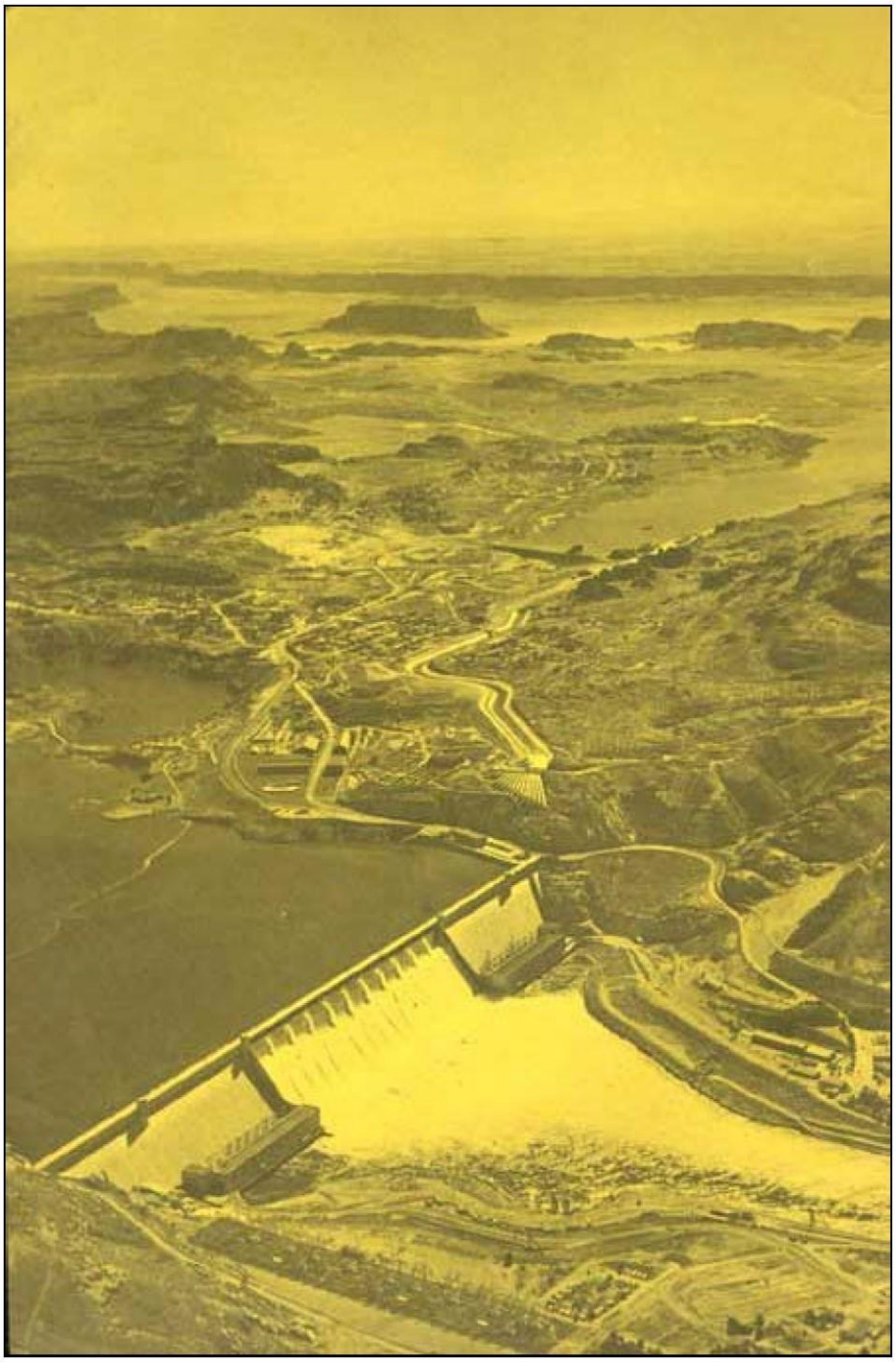
Tours of the dam are on a self-guided basis, allowing each visitor to set his own pace. These tours may be taken any day from 6 a.m. to 9 p.m. during the winter months, and from 6 a.m. to 11 p.m. during the summer.

One of the major attractions at Grand Coulee is the dam's right power house, located on the east bank of the river. Here the visitor can see the generators, turbines, and transformers performing their daily jobs. The top of the dam is open to both pedestrians and passenger vehicles.

In the dam's pumping plant, which houses the giant irrigation pumps that lift the irrigation waters of the project 280 feet up from Franklin D. Roosevelt Lake to Banks Lake, a large talking topographical map and a series of murals and displays about the room explain the Columbia Basin Project, its purpose, its past, and its future.

When the spillway is in operation, usually beginning about Memorial Day and lasting through the summer, a colored floodlighting program is presented nightly. This system of 742 amber, green, blue, red, and white lights operates in conjunction with a recorded musical program, bathing the dam in an aura of music and color. The lights and music run from dusk to midnight during the summer.

Scattered elsewhere throughout the project are a host of other picturesque and instructive sights partially described in this booklet. They include the waterways and irrigation structures of the project area—the miles of river-wide main canal, gigantic siphons, and the many reservoirs and seep lakes. There are valleys of checkerboard fields and orchards and a range of topography unmatched in this region. Each year these sights are viewed by thousands of tourists and an increasing number of groups. For additional information concerning the specific location of sights to be seen on the Columbia Basin Project, or on any of its activities, please feel free to contact the project headquarters in Ephrata.



DATA ON THE DAM AND PROJECT

GRAND COULEE DAM

Length at crest	4,173 feet.

Height above lowest bedrock	550 feet.
Height above downstream water level	350 feet.
Pump lift to Feeder Canal	280 feet.
Spillway width	1,650 feet.
Concrete content	10,585,000 cubic yards.
Excavation for dam, common	20,535,422 cubic yards.
Excavation for dam, rock	2,095,557 cubic yards.
Maximum concrete pour, 1 month	536,264 cubic yards.

FRANKLIN D. ROOSEVELT LAKE

Area	80,000 acres.
Length	151 miles.
Length of shoreline	600 miles.
Total capacity	9,402,000 acre-feet.
Live capacity	5,072,000 acre-feet.
Maximum surface elevation above sea level	1,290 feet.

COLUMBIA RIVER AND TRIBUTARIES

Total drainage area	258,000 square miles.
Total drainage area above Grand Coulee Dam	74,100 square miles.
Drainage area in Canada	39,700 square miles.
Mean annual runoff above dam	77,200,000 acre-feet.
Maximum required for irrigation	4,000,000 acre-feet.
Mean annual flow at dam	104,150 cubic feet per second.
Maximum recorded flow at dam, 1948	637,800 cubic feet per second.

POWER PLANTS

Turbines:	
(18)	160,000 horsepower each.
(3) (station service)	14,000 horsepower each.
Generators:	
(18)	108,000 kilowatts each.
(3) (station service)	10,000 kilowatts each.
Total rated capacity	1,974,000 kilowatts.

PUMPING PLANT

Pumps (12 ultimate, 6 installed)	65,000 horsepower each.
Capacity (each pump)	1,600 cubic feet per second.

FEEDER CANAL

Length	1.6 miles.
Capacity	16,000 cubic feet per second.

EQUALIZING RESERVOIR

Length of reservoir	27 miles.

Active storage	761,800 acre-feet.
Water surface elevation	1,570 feet.
Water surface area	27,000 acre-feet (42 miles).
Maximum water depth	85 feet.

NORTH DAM (earthfill)

Length	1,450 feet.
Height above bedrock	145 feet.

DRY FALLS DAM (earthfill)

Length	9,800 feet.
Height above bedrock	123 feet.
Height above ground surface	80 feet.
Maximum width at base	480 feet.
Volume of fill materials	1,473,000 cubic yards.

MAIN CANAL TO LONG LAKE RESERVOIR

Length	8 miles.
Capacity	13,200 cubic feet per second.
Height of Summer Falls	165 feet.

LONG LAKE DAM AND RESERVOIR (part of Main Canal)

Length of dam	1,900 feet.
Height above bedrock	130 feet.
Height above ground surface	111 feet.
Maximum width at bottom	600 feet.
Volume of fill material	1,462,000 cubic yards.
Length of reservoir	6.1 miles.
Live capacity	22,000 acre-feet.

LONG LAKE DAM TO BIFURCATION WORKS

Length	6.6 miles
Capacity	9,700 cubic feet per second.
Width at water surface	112 feet.
Width at base	50 feet.
Water depth	21 feet.

WEST CANAL

Length	87 miles.
Capacity at bifurcation works	5,100 cubic feet per second.

SOAP LAKE SIPHON

Length	12,883 feet (2.44 miles).
Maximum diameter (high head section)	22 feet 4 inches.
Head	236 feet.

Difference in elevation inlet and outlet	19 feet.

FRENCHMAN HILLS TUNNEL

Length	9,280 feet.
Diameter	14 feet.
Difference in elevation inlet and outlet	13.6 feet.

EAST LOW CANAL

Length:	
Present	87 miles.
Ultimate	130 miles.
Capacity at bifurcation works	4,500 cubic feet per second.

O'SULLIVAN DAM (EARTHFILL) AND POTHOLES RESERVOIR

Length	3.5 miles.
Maximum height above bedrock	200 feet.
Volume of earthfill	8,753,000 cubic yards.
Total capacity	615,600 acre-feet.
Live capacity	379,500 acre-feet.

POTHOLES CANAL

Length	68 miles.
Capacity at O'Sullivan Dam:	
Present	1,800 cubic feet per second.
Ultimate	3,900 cubic feet per second.

PROJECT ACREAGES

Gross area, irrigable and nonirrigable	2,500,000 acres.
Irrigable area	1,029,000 acres.

ACREAGE—WATER AVAILABLE BY YEARS—CUMULATIVE TOTALS

Year	*Acres*	*Year*	*Acres*
1948	5,790	1957	353,508
1950	7,109	1958	359,456
1952	72,753	1959	414,129
1953	131,529	1960	425,993
1954	188,577	1961	440,860
1955	251,282	1962	451,228
1956	306,060	1963	459,425

ACREAGE—USING WATER ON CROPS—CUMULATIVE TOTALS

Year	*Acres*	*Year*	*Acres*
1948	119	1956	174,788
1949	2,411	1957	203,097

1950	4,353	1958	238,312
1951	5,335	1959	266,590
1952	27,127	1960	294,195
1953	63,958	1961	314,239
1954	104,327	1962	345,637
1955	149,229	1963	370,322

SIZE OF FARM UNIT

	Acres		*Acres*
Minimum	10	Average	85
Maximum	160		