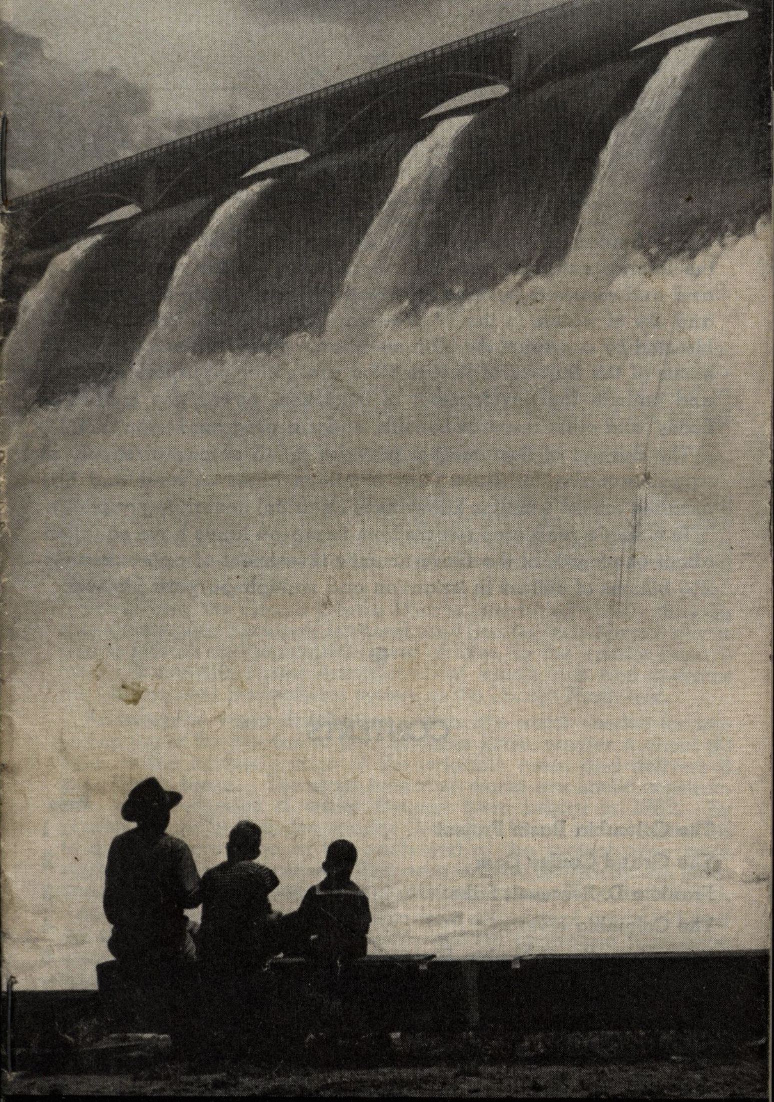
Columbia Basin PROJECT

GRAND COULEE DAM AND POWER PLANT



UNITED STATES DEPARTMENT OF THE INTERIOR

OSCAR L. CHAPMAN, Secretary

BUREAU OF RECLAMATION

MICHAEL W. STRAUS, Commissioner

DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, Secretary

The Department of the Interior is over 100 years old. It was established by the Vinton bill of March 3, 1849, to promote the domestic welfare by furthering the economic development of the Nation's natural resources and conserving them wisely. These resources include land, water, and minerals. Appropriate agencies have been established in the Department to carry out the conservation and development theme for the greatest benefit of present and future generations.

BUREAU OF RECLAMATION

Michael W. Straus, Commissioner

The Bureau of Reclamation is the agency of the Department of the Interior entrusted with the responsibility for the reclamation of arid and semiarid lands of the West and the control, development, and use of waters in the 17 Western States. These are the States bisected by or west of the 97th meridian. Many of the accomplishments of the Bureau of Reclamation are multiple-purpose in scope and include the development of irrigation, power, the control of floods, and other resource benefits, under a program begun in 1902.

The Bureau of Reclamation provides a full or partial supply of irrigation water for more than 5 million acres of land and has installed almost 4 million kilowatts of electrical generating capacity.

In a single year, crop returns from improved lands have equalled about one-fourth of the Government's investment of approximately 2½ billions of dollars in irrigation and multiple-purpose projects.

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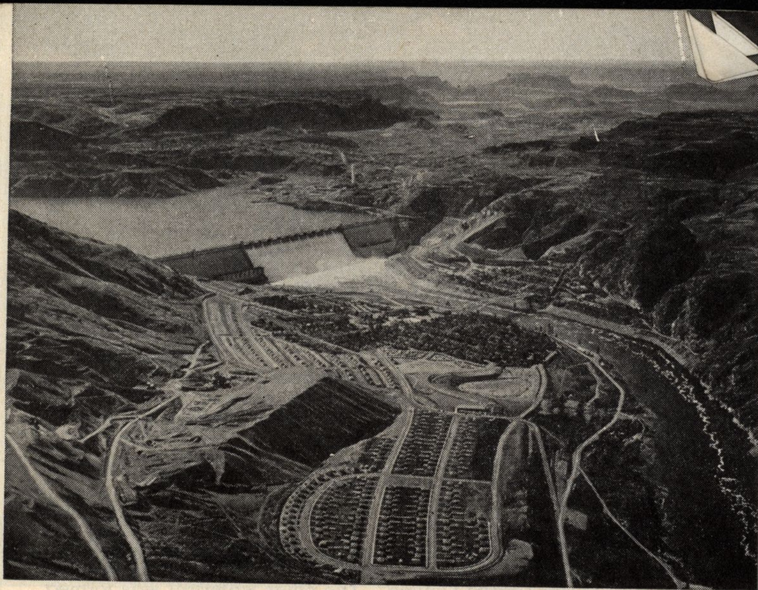

The Grand Coulee Dam stands on a granite base, exposed when summer floods from the Cordilleran ice cap cut in the Columbia lava plateau the 1,600-foot canyon in which the Columbia River flows.

THE COLUMBIA BASIN PROJECT

The Columbia Basin project is a multiple-purpose Reclamation development to utilize part of the vast resources of the Columbia River. It is designed to reclaim about 1 million acres of land in south central Washington and will ultimately develop over 2¼ million kilowatts of electrical power.

During the war, the Grand Coulee Dam, its most spectacular feature, became, and it has since remained, the world's greatest producer of hydroelectric power. Twelve of its ultimate 18 main generators were in operation by November 1949, and its power output then exceeded 32½ million kilowatt-hours a day, and 950 million a month. Three additional generators were installed in 1950, and the final three in 1951.

Power from the Grand Coulee Dam is distributed chiefly through substations near Spokane, Portland, and Seattle, to industrial plants and to private and municipal power utilities, by the Interior Department's Bonneville Power Administration, which built and operates the Government transmission system in the Pacific Northwest.

An extensive water-distributing system lifts water needed for irrigation out of the canyon of the Columbia River, carries it about 60 miles to the northerly edge of the irrigable area, and delivers it to irrigated farms. The main irrigation works are under construction, and deliveries of water through them began in 1952. By pumping directly from the nearby Columbia River, water deliveries to a 5,400-acre area in the south end of the project area were started in 1948. Ultimately, that area will be served by the main canal system, and the pumping plant near Pasco will be dismantled.

Hundreds of thousands of people from all parts of the world visit the Grand Coulee Dam each year, and an increasing number is visiting the irrigable area and the construction jobs in progress there. Lectures on the project and guided tours of the powerhouse are conducted at Coulee Dam every day except Christmas.

The Grand Coulee Dam is 92 miles west and north of Spokane and 240 miles east of Seattle. It is accessible over hard-surfaced roads connecting with cross-State highways at Wilbur, Coulee City, Soap Lake, and Burke Junction, east of the Vantage Bridge over the Columbia. The irrigable area extends about 80 miles south from Ephrata to Pasco, and is about 60 miles wide, from the Big Bend of the Columbia River eastward.

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The Grand Coulee Dam is in an area of considerable geologic interest. It is at the northern border of the Columbia lava plateau, which lies between spurs of the Rocky Mountains on the east and the Cascades on the west, and extends several hundred miles southward from the Okanogan Highlands through eastern Washington, eastern Oregon, and southern Idaho, into Nevada and California. The plateau was formed by many successive flows of highly fluid basic lava from fissures in the earth's surface, at intervals of hundreds of thousands, and perhaps millions, of years.

During the last ice age, a continental glacier about 300 miles wide and 1,200 miles long covered the mountainous area of western Canada and Alaska, and extended into Washington and northern Idaho. The tremendous summer runoff from the ice cap cut in the northwestern part of the Columbia lava plateau the 1,600-foot canyon in which the Columbia River now flows. Two or more times, southerly advances of the glacier closed the river canyon, and forced water to overflow across country southwesterly to the canyons of the Snake and Columbia Rivers in southern Washington.

The principal ice-age diversion channel, 1½ to 5 miles wide and several hundred feet deep, is known as the Grand Coulee. It was created in the course of thousands of years by two great waterfalls, one of which originated near the site of the town of Soap Lake and formed the Lower Grand Coulee. The other waterfall was formed at a declivity in the lava plateau about 30 miles from the river canyon, and it cut out the much larger Upper Coulee. Public highways traverse both coulees. Points of scenic interest are the majestic Steamboat Rock in the Upper Coulee, the 417-foot Dry Falls at the head of the Lower Coulee, and a chain of picturesque lakes in the Lower Coulee. In 1951, the 27-mile equalizing reservoir was formed in the Upper Grand Coulee by pumping water for irrigation into it from the reservoir above the dam.

THE GRAND COULEE DAM

The Grand Coulee Dam is unique in being the largest concrete structure in the world, and in having a tremendous waterfall over its spillway in the summer time. These spectacular features make it a powerful attraction to tourists.

The dam is 4,173 feet long, stands about 370 feet above the surface of the river below it, contains about 10¼ million cubic yards of concrete, and weighs about 22 million tons. Its height from lowest bedrock is 550 feet. Nearly half its volume is below the river surface.

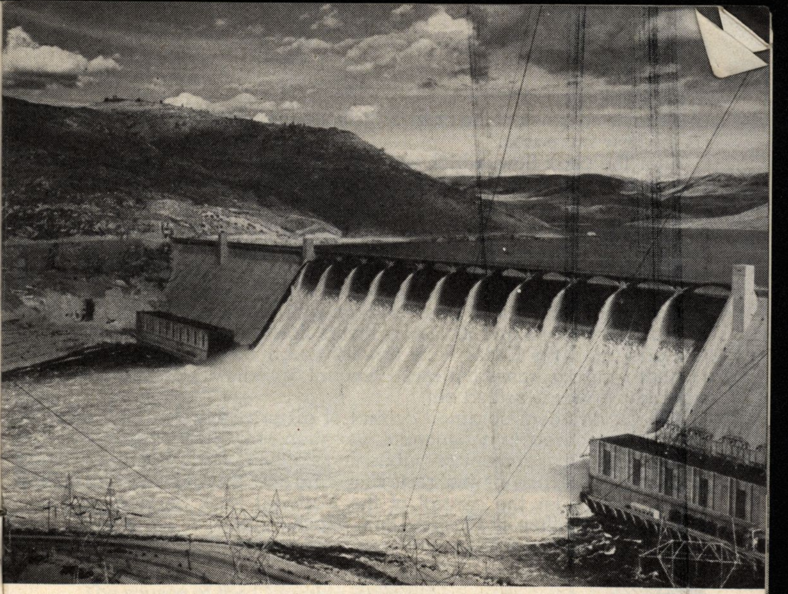
The central spillway is 1,650 feet wide, and the waterfall over it is half as wide and twice as high as Niagara Falls. At the peak of the summer flood, thousands of tons of surplus water flow over the spillway each second, and millions of kilowatts of energy go to waste in the wild, white water at its base. In the winter, the river is low for several weeks, and its entire flow then passes through the turbines in the powerhouses.

On each side of the spillway is a powerhouse nearly 800 feet long, and behind the dam at its west end is the pumping plant, between the west abutment and a "wing" dam about 600 feet long and about 150 feet high.

The dam rests on massive granite, a remnant of the foothills of the Okanogan Highlands, buried in the Columbia lava plateau millions of years ago, and exposed when summer torrents from the Cordilleran ice cap cut out of the lava and underlying granite the 1,600-foot canyon in which the Columbia River now flows. It is a "gravity" dam, depending on its weight alone to prevent the water pressure on its upstream face from tipping it over or causing it to slide on its base.

The site was chosen because a suitable granite foundation was available there, and because it is near the mouth of the Grand Coulee, through which water can be taken to irrigable land with minimum lift from the reservoir.

Within the dam are 8½ miles of inspection galleries and 2½ miles of shafts. Buried in the concrete are 1,700 miles of thin-wall steel tubing, through which cold water was circulated during the construction period to cool the concrete to the local mean annual



Millions of horsepower go to waste over the spillway of the Grand Coulee Dam during the high-water season of summer, while a fraction of the Columbia's flow drives the world's greatest powerplant.

temperature and to prevent the prolonged future shrinking and cracking that would result from slow, natural cooling.

The dam is economically useful because it raises water more than half way to the irrigation system, stores water for use in power generation in the low-water season of winter, and concentrates in one place the 350-foot fall and the energy formerly wasted in the 150-mile distance from the Canadian boundary, making it possible to generate hydroelectric power for pumping irrigation water and for industrial and domestic uses.

A 30-foot highway crosses the dam by way of the abutment sections of the dam and the 11 concrete arches over an equal number of drum gates at the crest of the spillway. The roadway on the dam is not a public highway and is open to the public only as construction activities and security measures permit.

FRANKLIN D. ROOSEVELT LAKE

A reservoir extending 151 miles from the dam to the Canadian boundary, the Franklin D. Roosevelt Lake, has been formed by the dam. It covers an area of 85,000 acres and averages 4,650 feet in width. The height of the dam was determined by the elevation of the river at the Canadian border, and the water level in the reservoir is not allowed to rise more than 1,290 feet above sea level, to avoid backing water into Canada and damaging property there.

The reservoir impounds about 9.7 million acre-feet of water, about half of which can be used to supplement the natural flow of the river in the wintertime when the flow is not sufficient to meet the power demand. No water need be stored in this reservoir for irrigation purposes because the flow of the river exceeds the requirements for both power and irrigation during the summer months. Additional storage capacity upstream will be required to meet increasing winter demands for power, and to provide flood protection for property along the lower river. Lake Roosevelt is a relatively small reservoir on a very large river and, alone, can be of little value for flood control. The peak flow in June 1948 would have filled the active capacity of the reservoir in 4 days. In conjunction with other proposed storage, however, substantial flood-control benefits will eventually be obtainable.

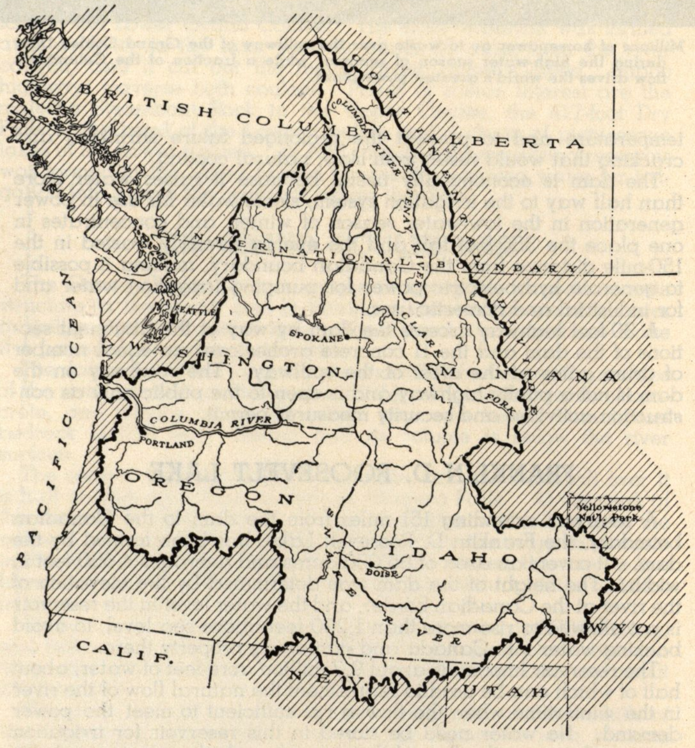
The lake level is maintained at elevation 1,290 feet above sea level throughout the summer, and the turbines and spillway must discharge as much water as flows into the lake. Beginning in the spring, the river flow exceeds the requirements for power generation, and the drum gates at the crest of the spillway are lowered gradually as the flow increases.

After the peak flow, which usually occurs in June, the drum gates are raised gradually to maintain the reservoir surface at elevation 1,290 and the pressure on the turbines at its maximum value.

The spillway is designed to discharge a million cubic feet of water per second if an unprecedented flood should make that necessary, and an additional 200,000 second-feet could be discharged through numerous 8½-foot outlet tunnels through the dam.

Lake Roosevelt will not be filled up with sediment for the reason that the Columbia and Kootenai Rivers flow through large lakes in Canada, and the Clark Fork flows through Lake Pend Oreille in northern Idaho, where the small amount of sediment carried by the mountain rivers is settled out.

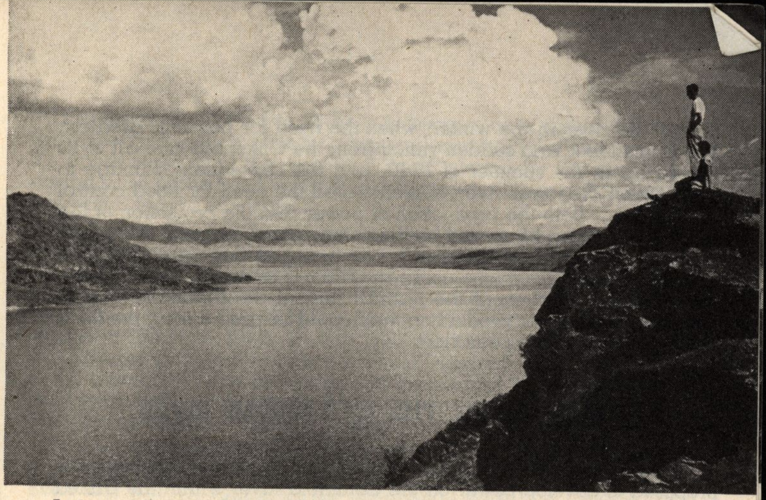
The Government obtained control of all privately owned land in the reservoir area to a minimum elevation of 1,310 feet above sea level. The development of public recreational facilities along the 600-mile shore line of the reservoir, and the private use of shore lands, are under the control of the National Park Service, which maintains an office at Coulee Dam, Wash.



The 259,000-square-mile basin of the Columbia River occupies parts of seven Pacific Northwest States, and 39,700 square miles in one province of Canada.

THE COLUMBIA RIVER

The Columbia River is the greatest power stream in North America. It drains an area of 259,000 square miles, and its basin includes nearly the whole of Washington, Oregon, and Idaho, that part of Montana west of the Rocky Mountains, small areas in Wyoming, Utah, and Nevada, and 39,700 square miles of mountainous country in the eastern part of British Columbia. About 60 percent of the water that passes the Grand Coulee Dam comes out of river basins in Canada.



A storage reservoir, Franklin D. Roosevelt Lake, extends from the Grand Coulee Dam to the Canadian boundary, 151 miles away. Water stored here will supplement the Columbia's low winter flow in producing power.

The source of the Columbia River is Columbia Lake, lying between the Canadian Rockies and Selkirk Mountains at an elevation of 2,650 feet. The river flows northwesterly 195 miles, turns sharply west and south around the Selkirks, and then flows southerly 270 miles to enter the United States in the northeastern corner of Washington, after passing through the Arrow Lakes in British Columbia.

The great volume of the Columbia, and its fall of 1,290 feet between the reservoir at the Grand Coulee Dam and tidewater below the Bonneville Dam, make it a potential source of tremendous wealth in the form of water power. Ten dams and power plants are proposed for the development of the main stream within the United States. The Grand Coulee Dam and power plant, built and operated by the Bureau of Reclamation, are the uppermost and largest of them. Bonneville Dam, built and operated by the Corps of Engineers, United States Army, is the lowermost. A third dam is now in operation at Rock Island, 150 miles below the Grand Coulee. It was built by the Puget Sound Power & Light Co., and was the first power development on the main stream. The McNary and Chief Joseph Dams are under construction by the Army Corps of Engineers, and others are planned.

The largest tributary of the Columbia is the Snake River, which rises in western Wyoming and drains central and southern Idaho, eastern Oregon, and the southeasterly part of Washington. It joins the Columbia River in south-central Washington, 323 miles above its mouth and 274 miles below the Grand Coulee Dam.

The second and third largest tributaries of the Columbia, the Kootenai and the Clark Fork Rivers, join it in Canada. The Kootenai rises in the Canadian Rockies, 75 miles north of the source of the Columbia, and flows south 180 miles into the United States, passing within a few miles of Columbia Lake, the source of the Columbia River. After traversing a 167-mile loop in Montana and Idaho, the Kootenai River returns into Canada and enters Kootenai Lake, which discharges into the Columbia.

The Clark Fork of the Columbia River drains almost all of western Montana. From its source in the Rocky Mountains, near Butte, and not far from the headwaters of the Missouri River, it flows generally northwesterly 360 miles into Lake Pend Oreille in northern Idaho, and thence nearly 100 miles west through Idaho and north through Washington, into Canada.

The upper Columbia is characterized by wide variations in its annual flow and by having its peak flow in summer, nearly always in June. Most of its water comes from snow and ice deposits in the high mountains of British Columbia, western Montana, and northern Idaho. Warm weather, thawing such deposits, accounts for the high summer flow and provides surplus water for irrigation and for power to pump the water.

The demand for power, which has spurted under the impact of defense needs, has called attention to the seriousness of the low flow of the river in the winter, when the need for power is greatest. The tremendous and sudden runoff from the Columbia and all of its tributaries in the summer of 1948, and the consequent damage to property on the lower river, demonstrated the need for flood control of the river. Both the production of power and the protection of life and property can be served by the same means, namely, reservoirs in the upper basins of the river's tributaries, in this country and in Canada. Such reservoirs could be drained or drawn down during the winter to supplement the natural flow of the Columbia and to maintain high power production, and could be used during the flood reason to reduce the peak flow.

POWER FROM THE COLUMBIA RIVER

The Grand Coulee Dam is 1 of 10 dams by means of which it is proposed to develop power on the Columbia River within the United States, and make use of about 93 percent of its 1,290-foot fall between the Canadian boundary and tidewater below the Bonneville Dam. It is the uppermost, most powerful, and largest of them.

Water power is particularly important to the Pacific Northwest States because they have very little oil and coal. It is important to the Nation because it will help to develop a valuable part of the country, will strengthen the National defense, and will provide raw materials for industries in other parts of the country. Power from the Missouri and Columbia Rivers helps to provide Eastern industries with copper, zinc, aluminum, and other metals.

About one-third of the potential water power in the United States is in that part of the Columbia River Basin within the United States. Year-around power available from the river and its tributaries, without regulation by means of storage reservoirs, has been estimated at about 10,000,000 kilowatts. If the flows of the streams were under complete control, it would be about 50,000,000. We cannot expect to see complete regulation of stream flows in the basin for want of storage reservoir sites, nor to see complete use made of seasonal peak flows, but with developments within practicable limits the prime power available from the Columbia Basin may be 30,000,000 kilowatts or more.

One proposed combination of dams on the main stream includes:

Name of site	Miles from mouth	Pool elevation	Gross head	Approximate capacity (kilowatt) [1]
1. Grand Coulee	597	1,288	348	1,974,000
2. Chief Joseph [2] (Foster Creek)	546	937.5	177	1,280,000
3. Chelan (or Wells)	516	767	64	392,000
4. Rocky Reach	475	699	93	585,000
5. Rock Island [3]	453	599	32	60,000
6. Priest Rapids	397	550	150	1,219,000
7. McNary (Umatilla)[2]	292	340	88	910,000
8. John Day	217	255	98	1,105,000
9. The Dalles	193	160	91	980,000
10. Bonneville [2]	145	72	64	518,400

[1] Excluding station-service units.
[2] Existing or under construction by Army Corps of Engineers.
[3] Puget Sound Power & Light Co.

Dams are completed and power plants are in operation at Grand Coulee, Rock Island, and Bonneville; and the McNary (Umatilla) Dam and the Chief Joseph (Foster Creek) Dam are under construction. Priest Rapids Dam is proposed for early authorization and construction. As engineering studies progress, some changes may be made in early proposed plans.

How great the Columbia River is to become as a power producer will depend largely on the building and managing of reservoirs on the upper reaches of the river and its tributaries for the purpose of storing some of the flood water of summer and releasing it during the low-water season of winter.

The power plant at the Grand Coulee Dam was loaded fully and continuously throughout every winter from the time it began operating in 1941 until the winter of 1949–50, partly in furnishing power to private and municipal utilities whose reservoirs would not carry their current loads through the winter. Fortunately, except in the winters of 1943–44, 1948–49, and 1950–51, the flow of the Columbia was always sufficient to operate at full capacity all its equipment so far installed. Now the water requirements of the installed equipment exceed the usual winter inflow to the reservoir, and it will hereafter be necessary to use some stored water for power generation.

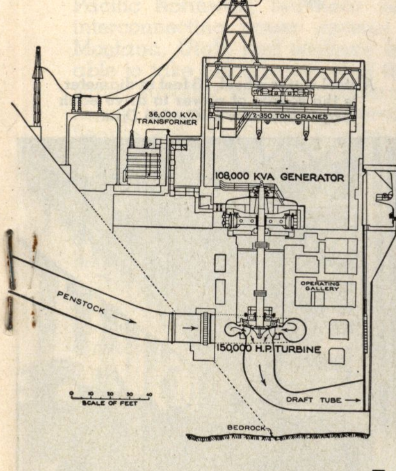
Power available from stream flow can be supplemented by releasing water from Lake Roosevelt to the extent of 5 million acre-feet. Even that will not suffice for the generating units now installed and for the growing demands for power, so additional storage capacity must be developed upstream. The Hungry Horse Dam, under construction by the Bureau of Reclamation in western Montana, and proposed developments on the Kootenai and Pend Oreille Rivers will augment the winter flow at and below the Canadian boundary, and will increase the winter generating capacity at Grand Coulee and Bonneville Dams and at any other power plants built on the main stream. Additional upstream reservoirs will be required as the power load develops.

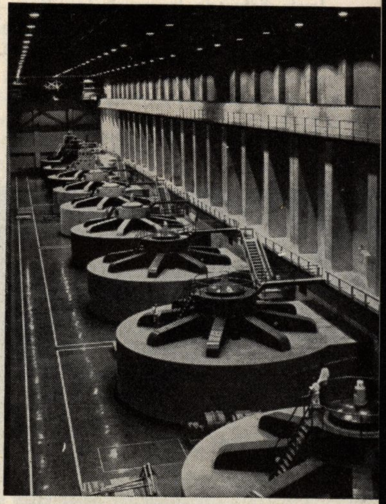
POWERPLANT AT THE GRAND COULEE DAM

The powerplant at the Grand Coulee Dam is unequaled as a power producer. With its completion in 1951, it contains 18 large generators, each rated at 108,000 kilowatts but actually capable of yielding more than 120,000 kilowatts, and 3 units of 10,000-kilowatt capacity each.

The generators and turbines are by far the most powerful in the world, but they are not, physically, the biggest. Larger units will

Cross-section through left powerhouse. Six of the nine large generators in the left powerhouse are designed to drive two 65,000-horsepower pump motors during the irrigation season.





be found in downstream plants, where less powerful turbines must handle much greater volumes of water at lower pressures and lower turbine speeds.

Power to drive one of the generators is derived from a 16-foot steel water wheel, mounted on a vertical shaft and surrounded by a huge spiral scroll case which is shaped like the outer turn of a snail shell. Water from the reservoir is carried diagonally downward through the dam in an 18-foot penstock, a steel pipe embedded in the concrete. Through a tapered elbow, the water enters the 15-foot mouth of the horizontal scroll case. As it flows around the spiral, it issues from a 34-inch horizontal circular slot at a velocity of about 50 miles per hour, and enters the water wheel around its entire circumference through a corresponding slot. The water, whirling horizontally and pressing against the blades in the water wheel, is slowed down to a velocity of about 5 miles per hour as it gives up most of its energy to the wheel and is forced vertically downward between the blades of the water wheel into a huge concrete elbow, through which it is discharged into the river below the dam. Water flowing over the spillway is surplus; no power is derived from it.

As the load on the generator varies, the flow of water through the turbine must be increased and diminished so precisely that the generator speed will be practically uniform. That is accomplished by the automatic adjustment of wicket gates around the water wheel, within the turbine casing, to control the flow of water from the scroll case into the water wheel. A governor, sensitive to the slightest change in the speed of the generator, controls the wicket gates. At full load, water under a pressure of 145 pounds per square inch flows through each turbine at the rate of 150 tons per second.

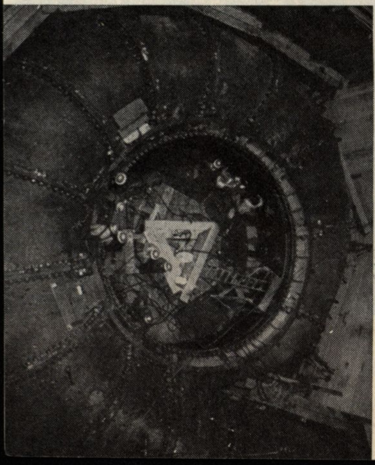
A single generator weighs about a thousand tons, and a turbine half as much. Neither was ever completely assembled until it was installed in the powerhouse. About 40 carloads of parts are required for one generator, and about 20 carloads for a turbine. Some single pieces weigh as much as 72 tons. While a turbine is being installed, and having a concrete base for a generator built over it, parts of the generator are built up elsewhere in subassemblies, to be combined later. One such subassembly, the rotor, weighs 587 tons. Two 350-ton traveling cranes in each powerhouse handle machine parts and subassemblies.

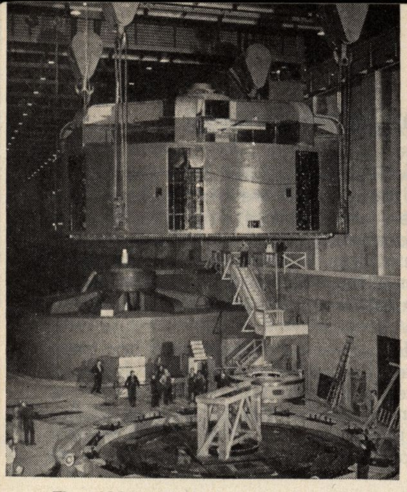
All the generators and turbines in one powerhouse are under the remote control of operators in a control room.

Outside the powerhouse, opposite each of the generators inside, is a group of three transformers which take energy from the generator at 13,800 volts and deliver it to outgoing lines at 230,000 volts. Through oil circuit breakers in the switchyard, operated from the control room in the powerhouse, connections are made with the long-distance transmission lines of the Bonneville Power Administration, which distributes and sells the power output from the Bonneville and Grand Coulee Dams.

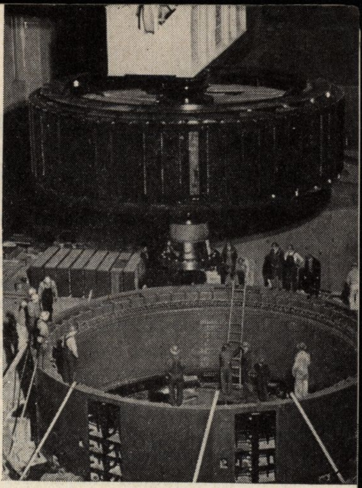
A spiral scroll case surrounds each turbine waterwheel and supplies it with 150 tons of water per second.

A steel water wheel, 16 feet in diameter, is the source of power to drive each large generator at Coulee Dam.





The 400-ton stationary section of a giant generator is set in place on a concrete and steel base by two 350-ton overhead cranes.



Sixty powerful electromagnets mounted on the rotor, moving 130 miles an hour within the stator, generate electricity in the stator windings.

THE NORTHWEST POWER POOL

The demand for electrical energy for industrial, commercial, and domestic uses varies from hour to hour and from month to month, and power plants must have sufficient capacity to meet daily and annual peak demands. Power requirements are greatest where people and industries are concentrated, and steam power plants are built as near to load centers as water supplies for condensers will permit. Water power plants must be built where nature has provided falling water, usually remote from cities and industrial centers. They must be supplemented with transmission lines connecting them with distributing substations near load centers to enable them to serve the purposes that are served by steam power stations. It would be impossible for every power consumer to build his own transmission lines to remote water power plants.

Since stream flows vary and cannot be regulated completely by reservoirs, most water power plants vary in capacity from month to month. If many water power plants that have their high and low capacities at different times can be interconnected, they can help each other in times of need, and so can serve more people or industries. Through interconnections, they can use, in one place, energy which otherwise would go to waste as local surplus elsewhere.

As early as 1923, three local power pools began to form in the Pacific Northwest, two near Seattle and Portland, and a third interconnecting power systems in eastern Washington, western Montana, Utah, and southern Idaho. These local pools were not able to take full advantage of the diversity of power demands and water supplies in widely separated areas until the Government's heavy transmission lines interconnecting Spokane, Portland, and Seattle with the Grand Coulee and Bonneville power plants were put into service in 1942, uniting them in one five-State pool extending into two time belts, where peak demands occur at different hours. As a result of being able to transmit local surpluses of power to distant points over the Government transmission lines, the power capacity of the Pacific Northwest was increased about 300,000 kilowatts without installing additional generating equipment.

The Northwest Power Pool is a voluntary grouping of 11 private, municipal, and Government power systems in Washington, Oregon, Idaho, Montana, and Utah. Its peak generating capacity is nearly 6 million kilowatts.

THE NEED FOR MORE POWER

It is common knowledge that with power and machinery to supplement our physical strength and manual skill we can produce more and better food, clothing, shelter, conveniences, and luxuries, and also more and better means of defending ourselves against aggressors than we could have without power and machinery. Our high level of living is chiefly a matter of the intelligent use of power and machinery. If we would have more, we must produce more; we must use more power.

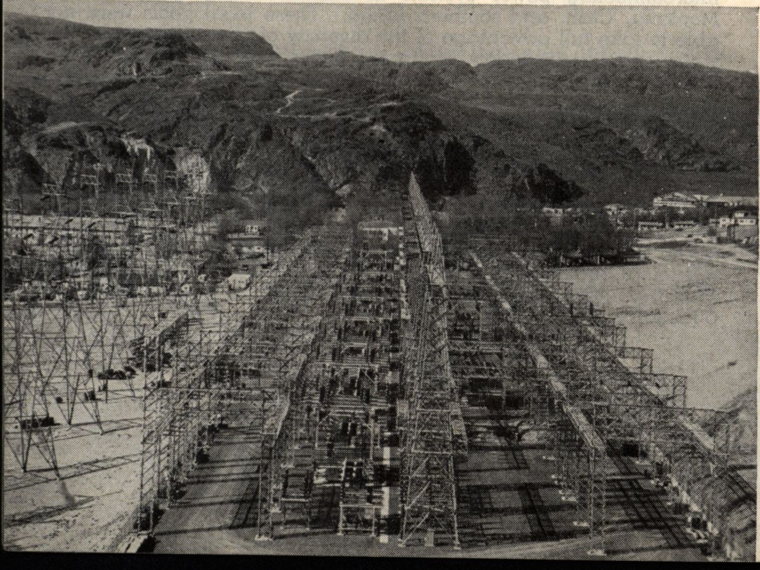
Use has always been found for power as rapidly as it has been developed. Progress and better living standards have followed power development, because they are dependent chiefly on the use of power. With the population of the country increasing at the rate of a million a year, more power must be developed if we are to maintain our present levels of living, and still more power if we are to reach higher standards.

The beneficiaries of power are not always residents of either the community in which the power is developed or the area in which the power is applied to industry. Residents of all parts of the country are beneficiaries of Missouri River power if they use or are served by devices or agencies which use Montana copper. People in all parts of the country are the beneficiaries of power generated and used in the industrial regions of the East and Middle West. Every citizen of the United States has profited by the contributions of Pacific Northwest power projects to the defense and war programs and to the production of aluminum.

Because of the availability of low-cost power, chiefly from the Grand Coulee Dam, the Pacific Northwest has become one of the foremost aluminum centers of the world. Nearly one-half of all the aluminum made in the United States comes from this area. Before the war it was a minor figure in the aluminum production field. The same low-cost power has helped give the area new industries by the score, including metallurgical and chemical plants, food-processing establishments, and textile mills.

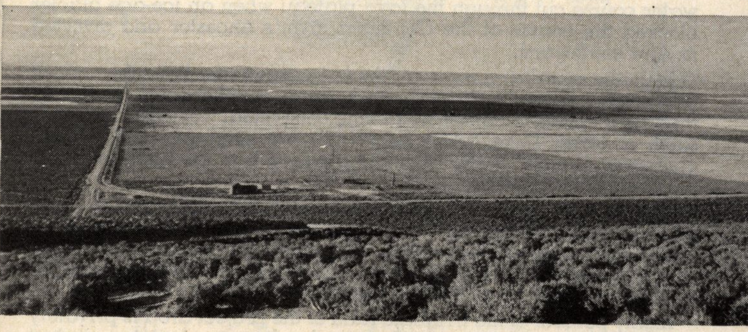
The world's greatest power plant, on the Columbia River, made possible the atomic energy installations at Hanford, Wash., and other war-born developments which today are leading elements in the peacetime economic advancement of the United States. Contrary to many forecasts, the demand for Columbia River power did not lapse after the war, but has exceeded even the most optimistic predictions of a decade ago.

In switchyards near the dam, connections are made between generators and long-distance transmission lines to substations near Spokane, Portland, and Seattle. There, interconnections are made with industries and with public and private power systems.



So we may be less likely to be attacked in the future, and so we may be able to defend ourselves better and take offensive action sooner in case of attack, we should hereafter be well prepared for war, not only in terms of strictly military equipment and personnel, but in convertible industries and sources of power.

Evidence of the importance of cheap power in our social and economic affairs is constantly before us; the importance of power in defense and war has been forcefully demonstrated in recent years, and the wisdom of having power resources developed in advance of pressing needs should now be clear to every thoughtful person.

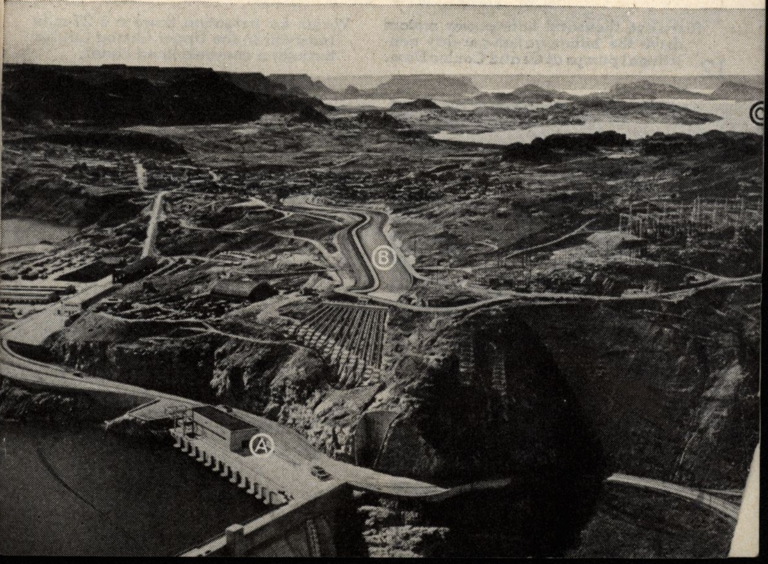


Large areas of sagebrush land and thousands of abandoned farms are to be irrigated with water diverted from the Columbia River at the Grand Coulee Dam.

THE IRRIGATION PROJECT

The lands to be irrigated with waters impounded behind Grand Coulee Dam lie in the Big Bend of the Columbia River, beginning some 60 miles south of the dam. The project area is approximately 100 miles long, north and south, and 60 miles wide, east and west. It embraces about 1,000,000 acres, now semiarid, which have been found suitable for irrigation.

The completed water-distributing system will include a pumping plant (A) to lift water 280 feet into a feeder canal (B), and a 27,000-acre reservoir in the Upper Grand Coulee.



Facilities for pumping the irrigation water from behind the dam into a large "equalizing reservoir" at an elevation of 280 feet above the surface of Lake Roosevelt, and for distributing it throughout the project area, are now under construction.

Ultimately, 12 pumps, the largest ever built, will be installed at the dam to force the water uphill through tunnels into a canal leading to the equalizing reservoir. The first six units are being installed now, and two are running. Each pump is driven by a 65,000-horsepower motor, with energy supplied by the power plant at the dam. Each pump has a capacity of more than 700,000 gallons of water per minute.

The equalizing reservoir is 27 miles long. It was formed by two earth-and-rock dams across the Grand Coulee, an abandoned water course cut through the lava plateau when an ice-age glacier blocked the course of the Columbia River's ancestor and diverted its flow southward.

From the equalizing reservoir the irrigation water flows throughout the project area by gravity, with some supplemental pumping, through a system of canals now being completed. Another reservoir south of Moses Lake, which in effect is an extension of that lake, conserves "runoff" water from irrigated lands in the north for reuse on lands to the south.

The first irrigation on the project went into operation in 1948 when pumping service for 5,400 acres near Pasco was inaugurated. Initial irrigation with water from behind Grand Coulee Dam began in the spring of 1952 with water which was pumped up into the equalizing reservoir in the late summer of 1951.

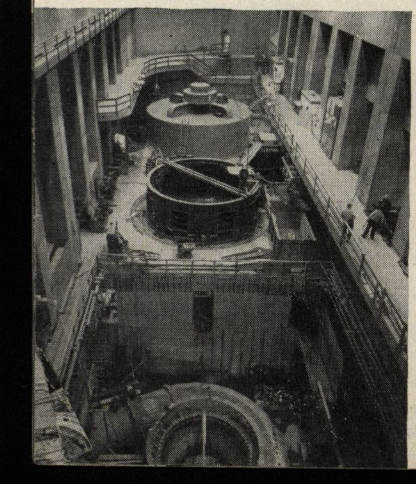
Eighty percent of the irrigable land of the project area is privately owned. Under Reclamation law, a landowner receiving project water may retain one family-size farm unit. All irrigable excess land eligible to be served by the irrigation system is being sold at the appraised price by the owners or is being purchased by the Government, divided into family-size units, and sold to settlers.

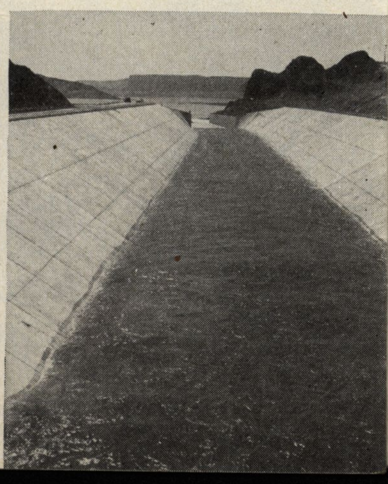
The land a person owns now or may purchase from present owners will not necessarily be that for which he will receive water, because land retained by owners must conform to the project's family-size farm pattern. Farm units generally will be laid out on a basis of land quality and contour, rather than on the basis of existing property lines.

All project land eligible to receive water is covered by definite antispeculation restrictions. All irrigable land has been surveyed, examined, classified, and appraised. The appraisal is based on dry-land values. The fact that the land will be irrigated is not considered in making the appraisals.

Sixty-five thousand horsepower motors drive the billion-gallon-per-day centrifugal pumps at Grand Coulee Dam.

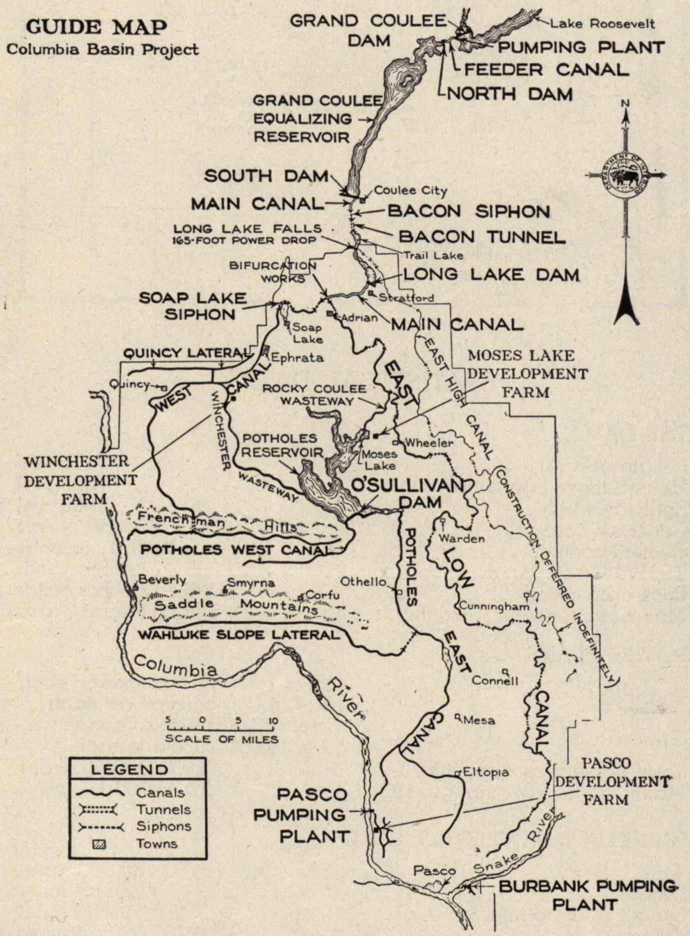
Water for irrigation flows to a 27-mile reservoir in the Upper Grand Coulee through a concrete-lined canal.





As a self-liquidating development, the project will repay to the United States Treasury virtually its entire cost. More than three-fourths the entire outlay for the dam, the network of canals, siphons and other irrigation structures will be repaid through the sale of power produced by the Grand Coulee power plant.

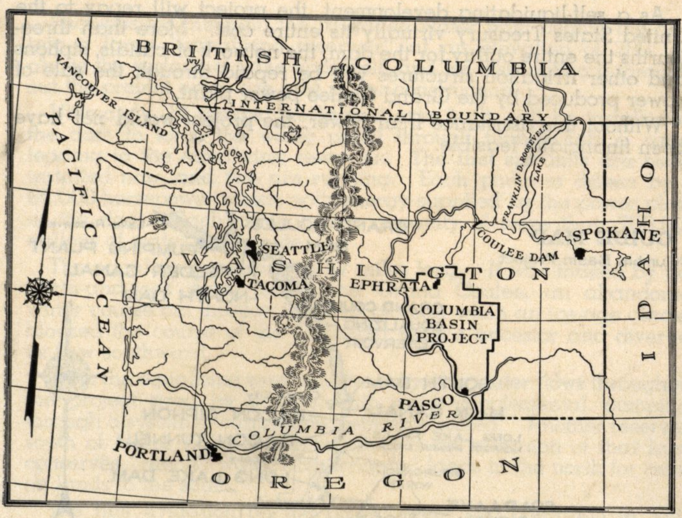
Without this assistance from power, the project would not have been financially feasible.



SOURCES OF INFORMATION

Information about the general activities of the Bureau of Reclamation is obtainable from the Commissioner, Bureau of Reclamation, Washington 25, D. C. Data concerning Bureau operations in the Pacific Northwest can be obtained from the regional director, Bureau of Reclamation, Boise, Idaho.

Requests for general information about the Columbia Basin project or for specific information about any parcel of land or about settlement of land should be addressed to the Bureau of Reclamation at Ephrata, Wash. Requests for information about Grand Coulee Dam, power from the dam, or pumping for irrigation should be addressed to the Bureau of Reclamation at Coulee Dam, Wash.



STATISTICAL DATA

THE DAM

Length at crest	4,173 feet
Height above lowest bedrock	550 feet
Spillway width	1,650 feet
Concrete content	10,230,776 cubic yards
Cement content	48,000 carloads
Excavation for the dam, common	20,535,422 cubic yards
Rock excavation	2,095,557 cubic yards
Maximum concrete, 1 month	536,264 cubic yards

POWER PLANT

Turbines	18 of 160,000 horsepower each 3 of 14,000 horsepower each
Generators	18 of 108,000 kilowatts each 3 of 10,000 kilowatts each
Total nameplate capacity	1,974,000 kilowatts
Maximum hourly output in 1951	2,226,000 kilowatts

FRANKLIN D. ROOSEVELT LAKE

Area	85,000 acres
Length	151 miles
Length of shore line	600 miles
Volume	9,700,000 acre-feet
Active capacity	5,165,000 acre-feet
Normal surface elevation above sea level	1,288–1,290 feet
Maximum draw-down	80 feet

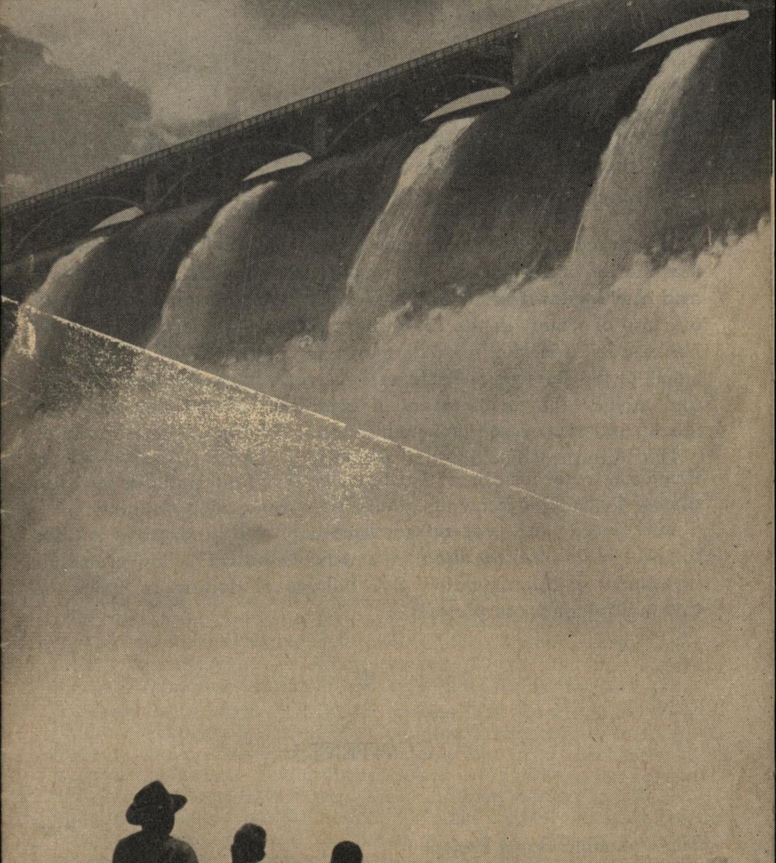
COLUMBIA RIVER BASIN

Area	259,000 square miles
Area above Coulee Dam	74,100 square miles
Area in Canada	39,700 square miles
Mean annual runoff above the dam	77,200,000 acre-feet
Maximum required for irrigation	4,000,000 acre-feet
Mean annual flow at the dam	104,150 second-feet
Maximum recorded flow, 1948	637,800 second-feet
Potential water power within the United States	30,000,000 kilowatts

U. S. GOVERNMENT PRINTING OFFICE: 1952

Columbia Basin PROJECT

GRAND COULEE DAM AND POWER PLANT



UNITED STATES DEPARTMENT OF THE INTERIOR
DOUGLAS McKAY, Secretary

BUREAU OF RECLAMATION
W. A. DEXHEIMER, Commissioner

DEPARTMENT OF THE INTERIOR

Douglas McKay, Secretary

The Department of the Interior is over 100 years old. It was established by the Vinton bill of March 3, 1849, to promote the domestic welfare by furthering the economic development of the Nation's natural resources and conserving them wisely. These resources include land, water, and minerals. Appropriate agencies have been established in the Department to carry out the conservation and development theme for the greatest benefit of present and future generations.

BUREAU OF RECLAMATION

W. A. Dexheimer, Commissioner

The Bureau of Reclamation is the agency of the Department of the Interior entrusted with the responsibility for the reclamation of arid and semiarid lands of the West and the control, development, and use of waters in the 17 Western States. These are the States bisected by or west of the 97th meridian. Many of the accomplishments of the Bureau of Reclamation are multiple-purpose in scope and include the development of irrigation, power, the control of floods, and other resource benefits, under a program begun in 1902.

The Bureau of Reclamation provides a full or partial supply of irrigation water for almost 7 million acres of land and has installed almost 4½ million kilowatts of electrical generating capacity.

In a single year, crop returns from improved lands have totalled almost 1 billion dollars, equaling nearly one-half of the Government's investment of approximately 2¼ billions of dollars in irrigation and multiple-purpose projects.

CONTENTS

[REVISED JUNE 1955]

The Grand Coulee Dam stands on a granite base, exposed when summer floods from the Cordilleran ice cap cut in the Columbia lava plateau the 1,600-foot canyon in which the Columbia River flows.

THE COLUMBIA BASIN PROJECT

The Columbia Basin project is a multiple-purpose Reclamation development to utilize part of the vast resources of the Columbia River. It is designed primarily to reclaim about 1 million acres of land in south central Washington.

During the war, the Grand Coulee Dam, its most spectacular feature, became, and it has since remained, the world's greatest producer of hydroelectric power. Twelve of its ultimate 18 main generators were in operation by November 1949, and its power output then exceeded 32½ million kilowatt-hours a day, and 950 million a month. Three additional generators were installed in 1950, and the final three in 1951, giving it a total installed capacity of 1,974,000 kilowatts.

Power from the Grand Coulee Dam is distributed chiefly through substations near Spokane, Portland, and Seattle, to industrial plants and to private and municipal power utilities, by the Interior Department's Bonneville Power Administration, which built and operates the Government transmission system in the Pacific Northwest.

An extensive water-distributing system lifts water needed for irrigation out of the canyon of the Columbia River, carries it about 60 miles to the northerly edge of the irrigable area, and delivers it to irrigated farms. The main irrigation works are under construction, and deliveries of water through them began in 1952. By pumping directly from the nearby Columbia River, water deliveries to a 5,400-acre area in the south end of the project area were started in 1948. Ultimately, that area will be served by the main canal system, and the pumping plant near Pasco will be dismantled.

Hundreds of thousands of people from all parts of the world visit the Grand Coulee Dam each year, and an increasing number is visiting the irrigable area and the construction jobs in progress there. Lectures on the project and guided tours of the powerhouse are conducted at Coulee Dam every day except Christmas.

The Grand Coulee Dam is 92 miles west and north of Spokane and 240 miles east of Seattle. It is accessible over hard-surfaced roads connecting with cross-State highways at Wilbur, Coulee City, Soap Lake, and Burke Junction, east of the Vantage Bridge over the Columbia. The irrigable area extends about 80 miles south from Ephrata to Pasco, and is about 60 miles wide, from the Big Bend of the Columbia River eastward.

The Grand Coulee Dam is in an area of considerable geologic interest. It is at the northern border of the Columbia lava plateau, which lies between spurs of the Rocky Mountains on the east and the Cascades on the west, and extends several hundred miles southward from the Okanogan Highlands through eastern Washington, eastern Oregon, and southern Idaho, into Nevada and California. The plateau was formed by many successive flows of highly fluid basic lava from fissures in the earth's surface, at intervals of hundreds of thousands, and perhaps millions, of years.

During the last ice age, a continental glacier about 300 miles wide and 1,200 miles long covered the mountainous area of western Canada and Alaska, and extended into Washington and northern Idaho. The tremendous summer runoff from the ice cap cut in the northwestern part of the Columbia lava plateau the 1,600-foot canyon in which the Columbia River now flows. Two or more times, southerly advances of the glacier closed the river canyon, and forced water to overflow across country southwesterly to the canyons of the Snake and Columbia Rivers in southern Washington.

The principal ice-age diversion channel, 1½ to 5 miles wide and several hundred feet deep, is known as the Grand Coulee. It was created in the course of thousands of years by two great waterfalls, one of which originated near the site of the town of Soap Lake and formed the Lower Grand Coulee. The other waterfall was formed at a declivity in the lava plateau about 30 miles from the river canyon, and it cut out the much larger Upper Coulee. Public highways traverse both coulees. Points of scenic interest are the majestic Steamboat Rock in the Upper Coulee, the 417-foot Dry Falls at the head of the Lower Coulee, and a chain of picturesque lakes in the Lower Coulee. In 1951, the 27-mile equalizing reservoir was formed in the Upper Grand Coulee by pumping water for irrigation into it from the reservoir above the dam.

THE GRAND COULEE DAM

The Grand Coulee Dam is unique in being the largest concrete structure in the world, and in having a tremendous waterfall over its spillway in the summer time. These spectacular features make it a powerful attraction to tourists.

The dam is 4,173 feet long, stands about 370 feet above the surface of the river below it, contains about 10¼ million cubic yards of concrete, and weighs about 22 million tons. Its height from lowest bedrock is 550 feet. Nearly half its volume is below the river surface.

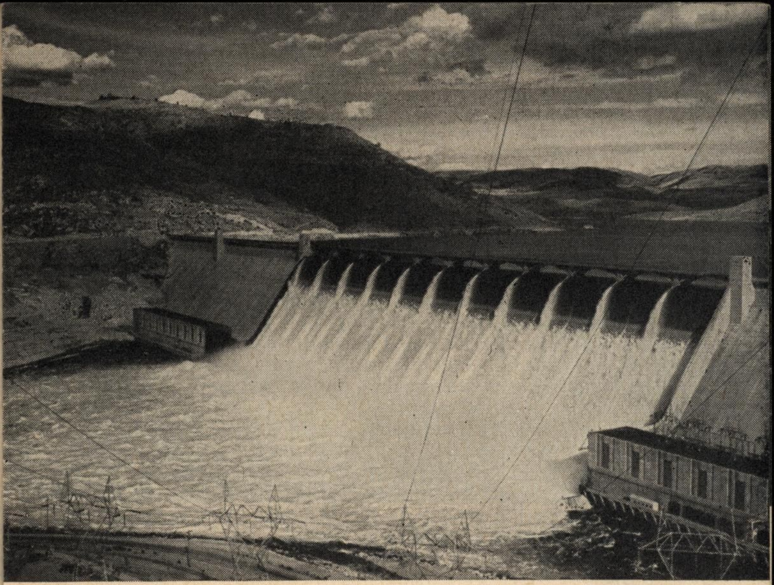
The central spillway is 1,650 feet wide, and the waterfall over it is half as wide and twice as high as Niagara Falls. At the peak of the summer flood, thousands of tons of surplus water flow over the spillway each second, and millions of kilowatts of energy go to waste in the wild, white water at its base. In the winter, the river is low for several weeks, and its entire flow then passes through the turbines in the powerhouses.

On each side of the spillway is a powerhouse nearly 800 feet long, and behind the dam at its west end is the pumping plant, between the west abutment and a "wing" dam about 600 feet long and about 150 feet high.

The dam rests on massive granite, a remnant of the foothills of the Okanogan Highlands, buried in the Columbia lava plateau millions of years ago, and exposed when summer torrents from the Cordilleran ice cap cut out of the lava and underlying granite the 1,600-foot canyon in which the Columbia River now flows. It is a "gravity" dam, depending on its weight alone to prevent the water pressure on its upstream face from tipping it over or causing it to slide on its base.

The site was chosen because a suitable granite foundation was available there, and because it is near the mouth of the Grand Coulee, through which water can be taken to irrigable land with minimum lift from the reservoir.

Within the dam are 8½ miles of inspection galleries and 2½ miles of shafts. Buried in the concrete are 1,700 miles of thin-wall steel tubing, through which cold water was circulated during the construction period to cool the concrete to the local mean annual



Millions of horsepower go to waste over the spillway of the Grand Coulee Dam during the high-water season of summer, while a fraction of the Columbia's flow drives the world's greatest powerplant.

temperature and to prevent the prolonged future shrinking and cracking that would result from slow, natural cooling.

The dam is economically useful because it raises water more than half way to the irrigation system, stores water for use in power generation in the low-water season of winter, and concentrates in one place the 350-foot fall and the energy formerly wasted in the 150-mile distance from the Canadian boundary, making it possible to generate hydroelectric power for pumping irrigation water and for industrial and domestic uses.

A 30-foot highway crosses the dam by way of the abutment sections of the dam and the 11 concrete arches over an equal number of drum gates at the crest of the spillway. The roadway on the dam is not a public highway and is open to the public only as construction activities and security measures permit.

FRANKLIN D. ROOSEVELT LAKE

A reservoir extending 151 miles from the dam to the Canadian boundary, the Franklin D. Roosevelt Lake, has been formed by the dam. It covers an area of 85,000 acres and averages 4,650 feet in width. The height of the dam was determined by the elevation of the river at the Canadian border, and the water level in the reservoir is not allowed to rise more than 1,290 feet above sea level, to avoid backing water into Canada and damaging property there.

The reservoir impounds about 9.7 million acre-feet of water, about half of which can be used to supplement the natural flow of the river in the wintertime when the flow is not sufficient to meet the power demand. No water need be stored in this reservoir for irrigation purposes because the flow of the river exceeds the requirements for both power and irrigation during the summer months. If additional storage capacity is provided upstream, it will help meet increasing winter demands for power and provide flood protection for property along the lower river. Lake Roosevelt is a relatively small reservoir on a very large river and, alone, can be of little value for flood control. The peak flow in the record flood period of June 1948 would have filled the active capacity of the reservoir in 4 days. In conjunction with other proposed storage, however, substantial flood-control benefits will eventually be obtainable.

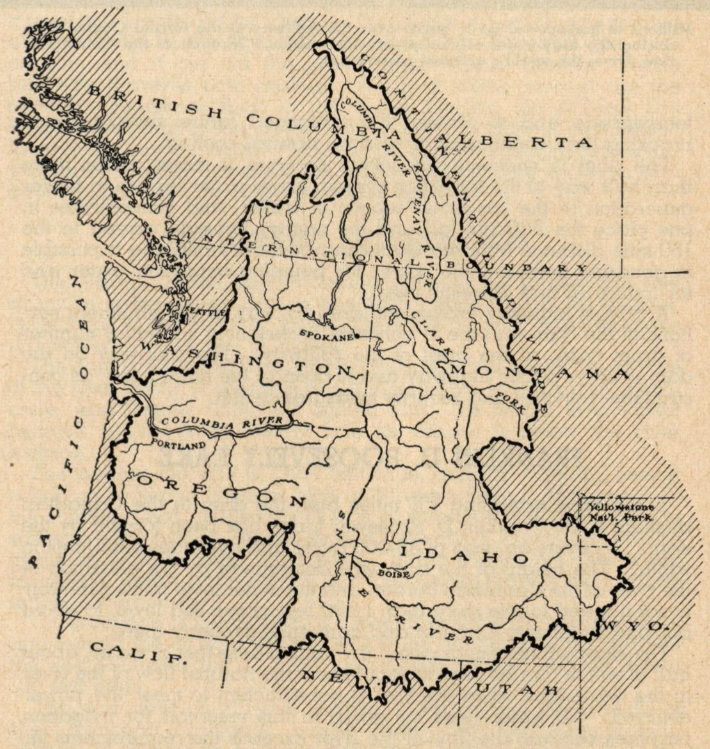
The lake level is maintained at elevation 1,290 feet above sea level throughout the summer, and the turbines and spillway must discharge as much water as flows into the lake. Beginning in the spring, the river flow exceeds the requirements for power generation, and the drum gates at the crest of the spillway are lowered gradually as the flow increases.

After the peak flow, which usually occurs in June, the drum gates are raised gradually to maintain the reservoir surface at elevation 1,290 and the pressure on the turbines at its maximum value.

The spillway is designed to discharge a million cubic feet of water per second if an unprecedented flood should make that necessary, and an additional 200,000 second-feet could be discharged through numerous 8½-foot outlet tunnels through the dam.

Lake Roosevelt will not be filled up with sediment for the reason that the Columbia and Kootenai Rivers flow through large lakes in Canada, and the Clark Fork flows through Lake Pend Oreille in northern Idaho, where the small amount of sediment carried by the mountain rivers is settled out.

The Government obtained control of all privately owned land in the reservoir area to a minimum elevation of 1,310 feet above sea level. The development of public recreational facilities along the 600-mile shore line of the reservoir, and the private use of shore lands, are under the control of the National Park Service, which maintains an office at Coulee Dam, Wash.



The 259,000-square-mile basin of the Columbia River occupies parts of seven Pacific Northwest States, and 39,700 square miles in one province of Canada.

THE COLUMBIA RIVER

The Columbia River is the greatest power stream in North America. It drains an area of 259,000 square miles, and its basin includes nearly the whole of Washington, Oregon, and Idaho, that part of Montana west of the Rocky Mountains, small areas in Wyoming, Utah, and Nevada, and 39,700 square miles of mountainous country in the eastern part of British Columbia. About 60 percent of the water that passes the Grand Coulee Dam comes out of river basins in Canada.

A storage reservoir, Franklin D. Roosevelt Lake, extends from the Grand Coulee Dam to the Canadian boundary, 151 miles away. Water stored here will supplement the Columbia's low winter flow in producing power.

The source of the Columbia River is Columbia Lake, lying between the Canadian Rockies and Selkirk Mountains at an elevation of 2,650 feet. The river flows northwesterly 195 miles, turns sharply west and south around the Selkirks, and then flows southerly 270 miles to enter the United States in the northeastern corner of Washington, after passing through the Arrow Lakes in British Columbia.

The great volume of the Columbia, and its fall of 1,290 feet between the reservoir at the Grand Coulee Dam and tidewater below the Bonneville Dam, make it a potential source of tremendous wealth in the form of water power. Ten dams and power plants are proposed for the development of the main stream within the United States. The Grand Coulee Dam and power plant, built and operated by the Bureau of Reclamation, are the uppermost and largest of them. Bonneville Dam, built and operated by the Corps of Engineers, United States Army, is the lowermost. A third dam is now in operation at Rock Island, 150 miles below the Grand Coulee. It was built by the Puget Sound Power & Light Co., and was the first power development on the main stream. McNary has been completed by the Corps of Engineers, and Chief Joseph and The Dalles Dams are under construction. In addition, the Corps has plans for other dams.

The largest tributary of the Columbia is the Snake River, which rises in western Wyoming and drains central and southern Idaho, eastern Oregon, and the southeasterly part of Washington. It joins the Columbia River in south-central Washington, 323 miles above its mouth and 274 miles below the Grand Coulee Dam.

The second and third largest tributaries of the Columbia, the Kootenai and the Clark Fork Rivers, join it in Canada. The Kootenai rises in the Canadian Rockies, 75 miles north of the source of the Columbia, and flows south 180 miles into the United States, passing within a few miles of Columbia Lake, the source of the Columbia River. After traversing a 167-mile loop in Montana and Idaho, the Kootenai River returns into Canada and enters Kootenai Lake, which discharges into the Columbia.

The Clark Fork of the Columbia River drains almost all of western Montana. From its source in the Rocky Mountains, near Butte, and not far from the headwaters of the Missouri River, it flows generally northwesterly 360 miles into Lake Pend Oreille in northern Idaho, and thence nearly 100 miles west through Idaho and north through Washington, into Canada.

The upper Columbia is characterized by wide variations in its annual flow and by having its peak flow in summer, nearly always in June. Most of its water comes from snow and ice deposits in the high mountains of British Columbia, western Montana, and northern Idaho. Warm weather, thawing such deposits, accounts for the high summer flow and provides surplus water for irrigation and for power to pump the water.

The demand for power, which has spurted under the impact of defense needs, has called attention to the seriousness of the low flow of the river in the winter, when the need for power is greatest. The tremendous and sudden runoff from the Columbia and all of its tributaries in the summer of 1948, and the consequent damage to property on the lower river, demonstrated the need for flood control of the river. Both the production of power and the protection of life and property can be served by the same means, namely, reservoirs in the upper basins of the river's tributaries, in this country and in Canada. Such reservoirs could be drained or drawn down during the winter to supplement the natural flow of the Columbia and to maintain high power production, and could be used during the flood season to reduce the peak flow.

POWER FROM THE COLUMBIA RIVER

The Grand Coulee Dam is 1 of 10 dams by means of which it is proposed to develop power on the Columbia River within the United States, and make use of about 93 percent of its 1,290-foot fall between the Canadian boundary and tidewater below the Bonneville Dam. It is the uppermost, most powerful, and largest of them.

Water power is particularly important to the Pacific Northwest States because they have very little oil and coal. It is important to the Nation because it will help to develop a valuable part of the country, will strengthen the National defense, and will provide raw materials for industries in other parts of the country. Power from the Missouri and Columbia Rivers helps to provide Eastern industries with copper, zinc, aluminum, and other metals.

About one-third of the potential water power in the United States is in that part of the Columbia River Basin within the United States. Year-around power available from the river and its tributaries, without regulation by means of storage reservoirs, has been estimated at about 10,000,000 kilowatts. If the flows of the streams were under complete control, it would be about 50,000,000. We cannot expect to see complete regulation of stream flows in the basin for want of storage reservoir sites, nor to see complete use made of seasonal peak flows, but with developments within practicable limits the prime power available from the Columbia Basin may be 30,000,000 kilowatts or more.

One proposed combination of dams on the main stream includes:

Name of site	Miles from mouth	Pool elevation	Gross head	Approximate capacity (kilowatt) [1]
1. Grand Coulee	597	1,288	348	1,974,000
2. Chief Joseph [2] (Foster Creek)	546	937.5	177	1,280,000
3. Chelan (or Wells)	516	767	64	392,000
4. Rocky Reach	475	699	93	585,000
5. Rock Island [3]	453	599	32	60,000
6. Priest Rapids	397	550	150	1,219,000
7. McNary (Umatilla) [2]	292	340	88	910,000
8. John Day	217	255	98	1,105,000
9. The Dalles [2]	193	160	91	980,000
10. Bonneville [2]	145	72	64	518,400

[1] Excluding station-service units.
[2] Existing or under construction by Army Corps of Engineers.
[3] Puget Sound Power & Light Co.

Dams are completed and power plants are in operation at Grand Coulee, Rock Island, McNary (Umatilla), and Bonneville; the Chief Joseph (Foster Creek) Dam and The Dalles Dam are under construction. As engineering studies progress, some changes may be made in early proposed plans.

How great the Columbia River is to become as a power producer will depend largely on the building and managing of reservoirs on the upper reaches of the river and its tributaries for the purpose of storing some of the flood water of summer and releasing it during the low-water season of winter.

The power plant at the Grand Coulee Dam was loaded fully and continuously throughout every winter from the time it began operating in 1941 until the winter of 1949–50, partly in furnishing power to private and municipal utilities whose reservoirs would not carry their current loads through the winter. Fortunately, except in the winters of 1943–44, 1948–49, and 1950–51, the flow of the Columbia was always sufficient to operate at full capacity all its equipment so far installed. Now the water requirements of the installed equipment exceed the usual winter inflow to the reservoir, and it will hereafter be necessary to use some stored water for power generation.

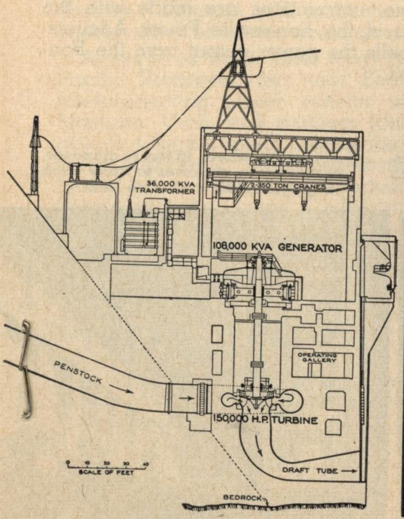
Power available from stream flow can be supplemented by releasing water from Lake Roosevelt to the extent of 5 million acre-feet. Even that will not suffice for the generating units now installed and for the growing demands for power, so additional storage capacity must be developed upstream. The Hungry Horse Dam, recently completed by the Bureau of Reclamation in western Montana, and proposed developments on the Kootenai and Pend Oreille Rivers will augment the winter flow at and below the Canadian boundary, and will increase the winter generating capacity at Grand Coulee and Bonneville Dams and at any other power plants built on the main stream. Additional upstream reservoirs will be required as the power load develops.

POWERPLANT AT THE GRAND COULEE DAM

The powerplant at the Grand Coulee Dam is unequaled as a power producer. With its completion in 1951, it contains 18 large generators, each rated at 108,000 kilowatts but actually capable of yielding more than 120,000 kilowatts, and 3 units of 10,000-kilowatt capacity each.

The generators and turbines are by far the most powerful in the world, but they are not, physically, the biggest. Larger units will

Cross-section through left powerhouse. Six of the nine large generators in the left powerhouse are designed to drive two 65,000-horsepower pump motors during the irrigation season.



be found in downstream plants, where less powerful turbines must handle much greater volumes of water at lower pressures and lower turbine speeds.

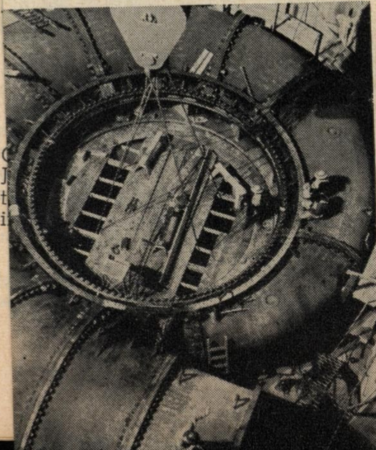
Power to drive one of the generators is derived from a 16-foot steel water wheel, mounted on a vertical shaft and surrounded by a huge spiral scroll case which is shaped like the outer turn of a snail shell. Water from the reservoir is carried diagonally downward through the dam in an 18-foot penstock, a steel pipe embedded in the concrete. Through a tapered elbow, the water enters the 15-foot mouth of the horizontal scroll case. As it flows around the spiral, it issues from a 34-inch horizontal circular slot at a velocity of about 50 miles per hour, and enters the water wheel around its entire circumference through a corresponding slot. The water, whirling horizontally and pressing against the blades in the water wheel, is slowed down to a velocity of about 5 miles per hour as it gives up most of its energy to the wheel and is forced vertically downward between the blades of the water wheel into a huge concrete elbow, through which it is discharged into the river below the dam. Water flowing over the spillway is surplus; no power is derived from it.

As the load on the generator varies, the flow of water through the turbine must be increased and diminished so precisely that the generator speed will be practically uniform. That is accomplished by the automatic adjustment of wicket gates around the water wheel, within the turbine casing, to control the flow of water from the scroll case into the water wheel. A governor, sensitive to the slightest change in the speed of the generator, controls the wicket gates. At full load, water under a pressure of 145 pounds per square inch flows through each turbine at the rate of 150 tons per second.

A single generator weighs about a thousand tons, and a turbine half as much. Neither was ever completely assembled until it was installed in the powerhouse. About 40 carloads of parts are required for one generator, and about 20 carloads for a turbine. Some single pieces weigh as much as 72 tons. While a turbine was being installed, and having a concrete base for a generator built over it, parts of the generator were built up elsewhere in subassemblies, to be combined later. One such subassembly, the rotor, weighs 587 tons. Two 350-ton traveling cranes in each powerhouse handle machine parts and subassemblies.

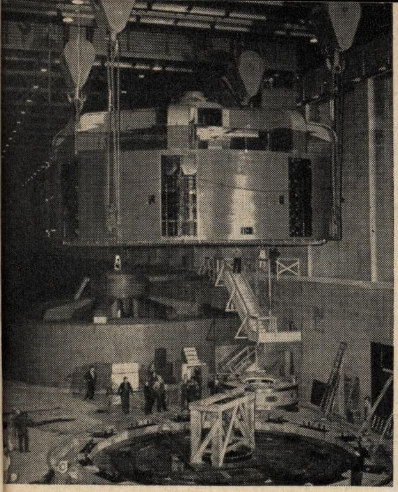
All the generators and turbines in one powerhouse are under the remote control of operators in a control room.

Outside the powerhouse, opposite each of the generators inside, is a group of three transformers which take energy from the generator at 13,800 volts and deliver it to outgoing lines at 230,000 volts. Through oil circuit breakers in the switchyard, operated from the control room in the powerhouse, connections are made with the long-distance transmission lines of the Bonneville Power Administration, which distributes and sells the power output from the Bonneville and Grand Coulee Dams.

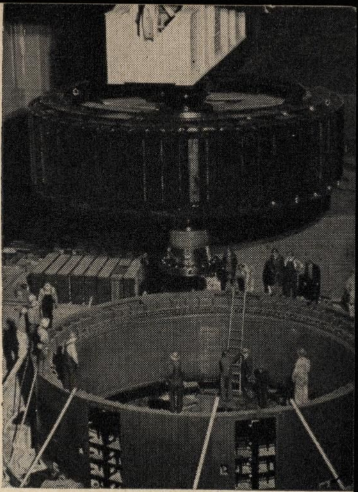


A spiral scroll case surrounds each turbine waterwheel and supplies it with 150 tons of water per second.

A steel water wheel, 16 feet in diameter, is the source of power to drive each large generator at Coulee Dam.



The 400-ton stationary section of a giant generator is set in place on a concrete and steel base by two 350-ton overhead cranes.



Sixty powerful electromagnets mounted on the rotor, moving 130 miles an hour within the stator, generate electricity in the stator windings.

THE NORTHWEST POWER POOL

The demand for electrical energy for industrial, commercial, and domestic uses varies from hour to hour and from month to month, and power plants must have sufficient capacity to meet daily and annual peak demands. Power requirements are greatest where people and industries are concentrated, and steam power plants are built as near to load centers as water supplies for condensers will permit. Water power plants must be built where nature has provided falling water, usually remote from cities and industrial centers. They must be supplemented with transmission lines connecting them with distributing substations near load centers to enable them to serve the purposes that are served by steam power stations. It would be impossible for every power consumer to build his own transmission lines to remote water power plants.

Since stream flows vary and cannot be regulated completely by reservoirs, most water power plants vary in capacity from month to month. If many water power plants that have their high and low capacities at different times can be interconnected, they can help each other in times of need, and so can serve more people or industries. Through interconnections, they can use, in one place, energy which otherwise would go to waste as local surplus elsewhere.

As early as 1923, three local power pools began to form in the Pacific Northwest, two near Seattle and Portland, and a third interconnecting power systems in eastern Washington, western Montana, Utah, and southern Idaho. These local pools were not able to take full advantage of the diversity of power demands and water supplies in widely separated areas until the Government's heavy transmission lines interconnecting Spokane, Portland, and Seattle with the Grand Coulee and Bonneville power plants were put into service in 1942, uniting them in one five-State pool extending into two time belts, where peak demands occur at different hours. As a result of being able to transmit local surpluses of power to distant points over the Government transmission lines, the power capacity of the Pacific Northwest was increased about 300,000 kilowatts without installing additional generating equipment.

The Northwest Power Pool is a voluntary grouping of 11 private, municipal, and Government power systems in Washington, Oregon, Idaho, Montana, and Utah. Its peak generating capacity is nearly 6 million kilowatts.

THE NEED FOR MORE POWER

It is common knowledge that with power and machinery to supplement our physical strength and manual skill we can produce more and better food, clothing, shelter, conveniences, and luxuries, and also more and better means of defending ourselves against aggressors than we could have without power and machinery. Our high level of living is chiefly a matter of the intelligent use of power and machinery. If we would have more, we must produce more; we must use more power.

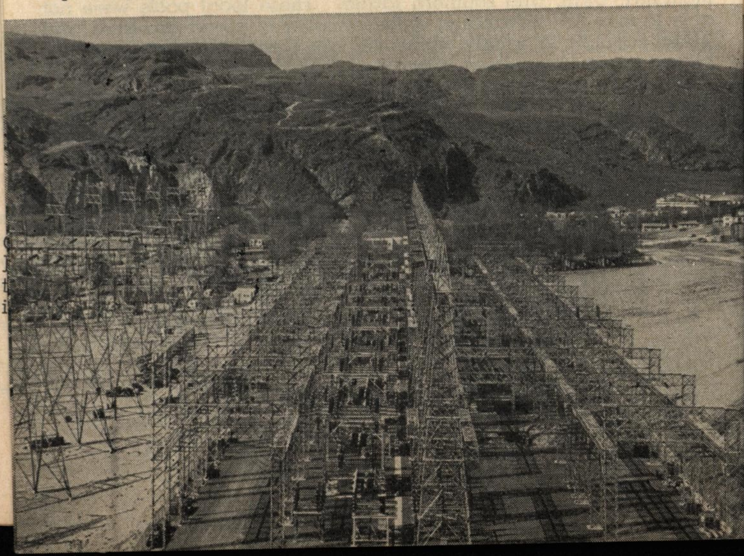
Progress and better living standards have followed power development, because they are dependent chiefly on the use of power. With the population of the country increasing at the rate of a million a year, more power must be developed if we are to maintain our present levels of living, and still more power if we are to reach higher standards.

The beneficiaries of power are not always residents of either the community in which the power is developed or the area in which the power is applied to industry. Residents of all parts of the country are beneficiaries of Missouri River power if they use or are served by devices or agencies which use Montana copper. People in all parts of the country are the beneficiaries of power generated and used in the industrial regions of the East and Middle West. Every citizen of the United States has profited by the contributions of Pacific Northwest power projects to the defense and war programs and to the production of aluminum.

Because of the availability of low-cost power, chiefly from the Grand Coulee Dam, the Pacific Northwest has become one of the foremost aluminum centers of the world. Nearly one-half of all the aluminum made in the United States comes from this area. Before the war it was a minor figure in the aluminum production field. The same low-cost power has helped give the area new industries by the score, including metallurgical and chemical plants, food-processing establishments, and textile mills.

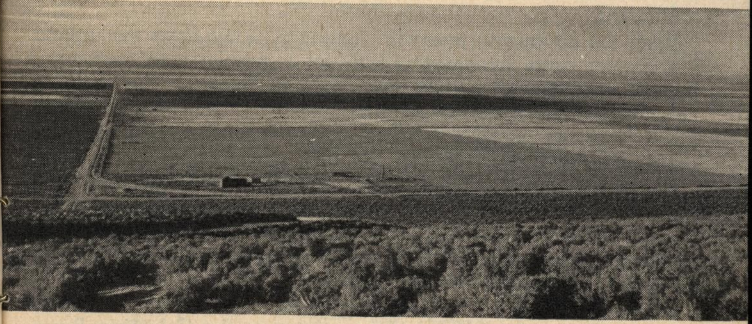
The world's greatest power plant, on the Columbia River, made possible the atomic energy installations at Hanford, Wash., and other war-born developments which today are leading elements in the peacetime economic advancement of the United States. Contrary to many forecasts, the demand for Columbia River power did not lapse after the war, but has exceeded even the most optimistic predictions of a decade ago.

In switchyards near the dam, connections are made between generators and long-distance transmission lines to substations near Spokane, Portland, and Seattle. There, interconnections are made with industries and with public and private power systems.



So we may be less likely to be attacked in the future, and so we may be able to defend ourselves better and take offensive action sooner in case of attack, we should hereafter be well prepared for war, not only in terms of strictly military equipment and personnel, but in convertible industries and sources of power.

The importance of cheap power in the development of our economy is constantly being demonstrated by the gravitation of major power-using industries to areas where such power is available. This, of course, leads to increasing demand for power and evidences of "shortages" in such areas. The wisdom of having power resources developed in advance of pressing needs has resulted in continuing efforts for full development of our river resources.

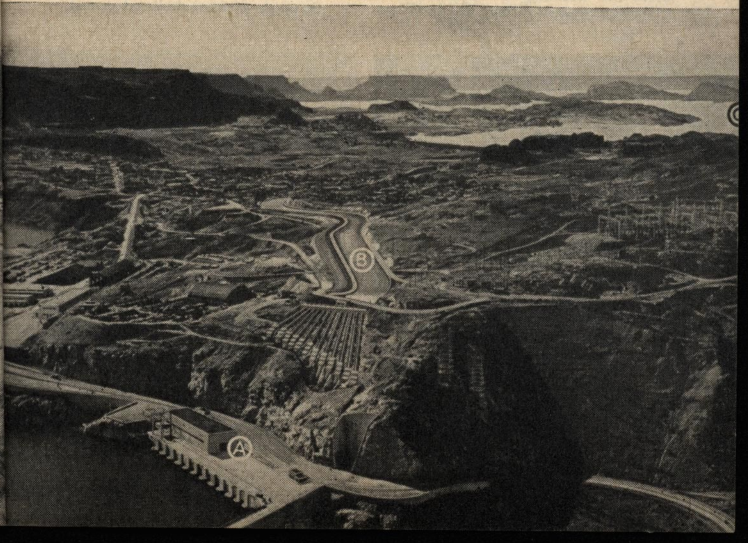


Large areas of sagebrush land and thousands of abandoned farms are to be irrigated with water diverted from the Columbia River at the Grand Coulee Dam.

THE IRRIGATION PROJECT

The lands to be irrigated with waters impounded behind Grand Coulee Dam lie in the Big Bend of the Columbia River, beginning some 60 miles south of the dam. The project area is approximately 100 miles long, north and south, and 60 miles wide, east and west. It embraces about 1,000,000 acres, now semiarid, which have been found suitable for irrigation.

The completed water-distributing system will include a pumping plant (A) to lift water 280 feet into a feeder canal (B), and a 27,000-acre reservoir in the Upper Grand Coulee.



Facilities throughout the project area are under construction for distributing irrigation water pumped from behind the dam into a large equalizing reservoir at an elevation 280 feet above the surface of Lake Roosevelt.

Twelve pumps, each with a capacity of 720,000 gallons per minute, will be installed ultimately at the dam to force water uphill through tunnels into a canal leading to the equalizing reservoir. The first six units are installed. They are the largest capacity pumps ever built. Each pump is driven by a 65,000-horsepower motor, with energy supplied by the powerplant at the dam.

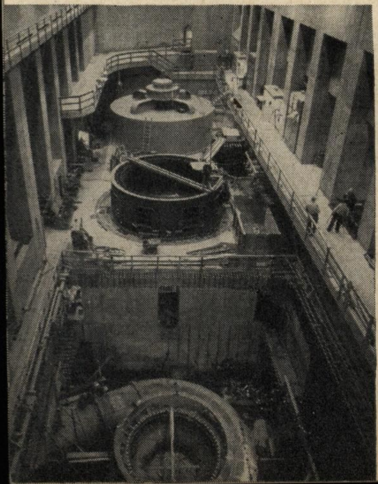
The equalizing reservoir is 27 miles long. It was formed between two earth-and-rock dams across the Grand Coulee, an abandoned water course cut through the lava plateau when an ice-age glacier blocked the flow of the Columbia River's ancestor and diverted it southward.

From the equalizing reservoir, irrigation water flows throughout the project area by gravity, with some supplemental pumping, through a system of canals now being completed. The Potholes Reservoir south of Moses Lake, which in effect is an extension of that lake, conserves runoff water from irrigated lands in the north for reuse on lands to the south.

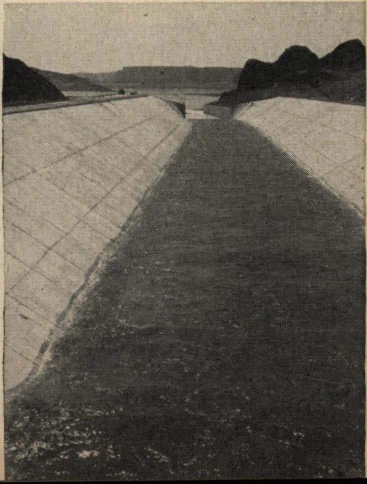
The first irrigation on the project began in 1948 when pumping from the Columbia River was inaugurated for 5,400 acres near Pasco. Initial irrigation with water from behind Grand Coulee Dam began in the spring of 1952 with water which was pumped into the equalizing reservoir in the late summer of 1951.

Eighty percent of the irrigable land of the project area is privately owned. Under the Federal law applying to the Columbia Basin project, a landowner receiving project water may retain one family-size farm unit. All irrigable excess land eligible to be served by the irrigation system is being sold at the appraised price by the owners or is being purchased by the Government, formed into family-size units, and sold to settlers. Farm units generally are laid out on a basis of land quality and contour, rather than on the basis of existing property lines.

All project land eligible to receive water is covered by definite antispeculation restrictions. All irrigable land has been surveyed, examined, classified, and appraised. The appraisal is based on dry-land values. The fact that the land will be irrigated is not considered in making the appraisals.



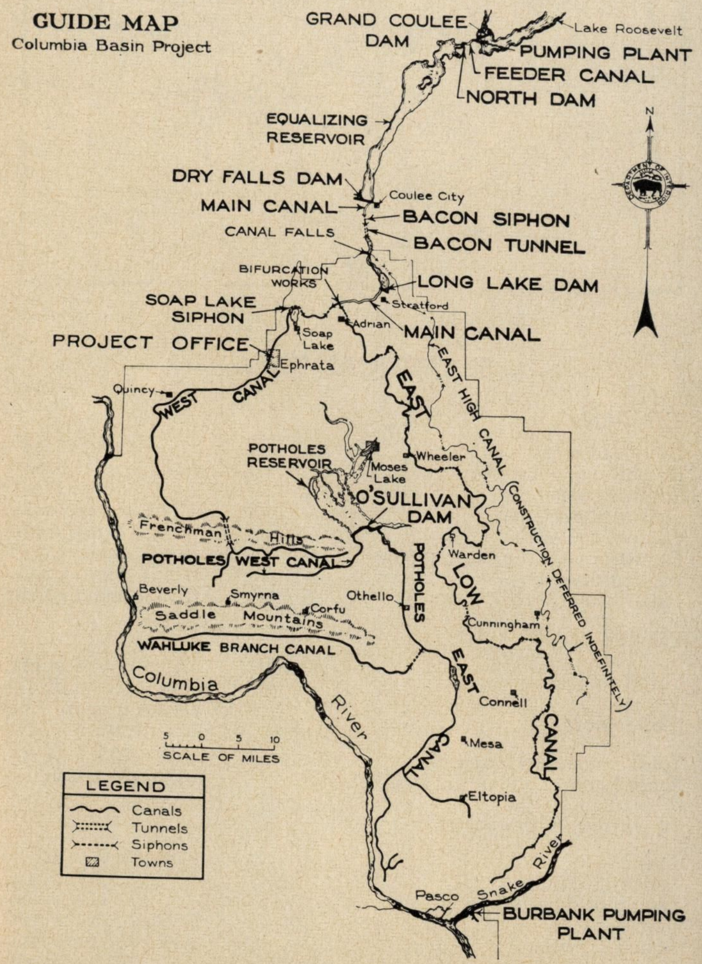
Sixty-five thousand horsepower motors drive the billion-gallon-per-day centrifugal pumps at Grand Coulee Dam.



Water for irrigation flows to a 27-mile reservoir in the Upper Grand Coulee through a concrete-lined canal.

As a self-liquidating development, the project will repay to the United States Treasury virtually its entire cost. More than three-fourths the entire outlay for the dam, the network of canals, siphons and other irrigation structures will be repaid through the sale of power produced by the Grand Coulee power plant.

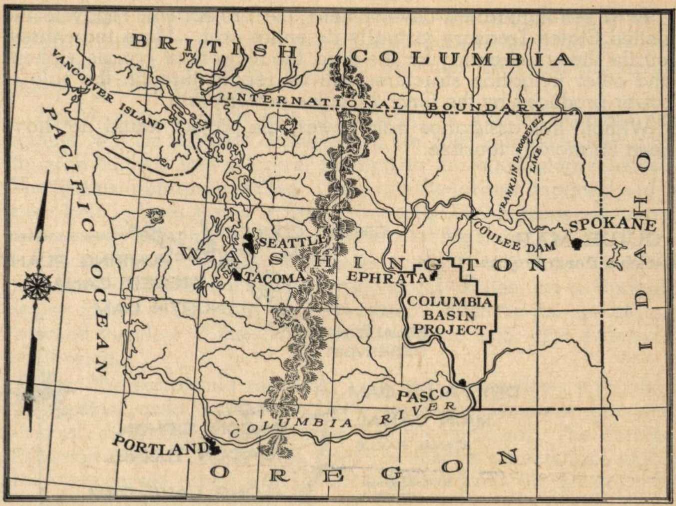
Without this assistance from power, the project would not have been financially feasible.



SOURCES OF INFORMATION

Information about the general activities of the Bureau of Reclamation is obtainable from the Commissioner, Bureau of Reclamation, Washington 25, D. C. Data concerning Bureau operations in the Pacific Northwest can be obtained from the regional director, Bureau of Reclamation, Boise, Idaho.

Requests for general information about the Columbia Basin project or for specific information about any parcel of land or about settlement of land should be addressed to the Bureau of Reclamation at Ephrata, Wash. Requests for information about Grand Coulee Dam, power from the dam, or pumping for irrigation should be addressed to the Bureau of Reclamation at Coulee Dam, Wash.



STATISTICAL DATA

THE DAM

Length at crest	4,173 feet
Height above lowest bedrock	550 feet
Spillway width	1,650 feet
Concrete content	10,230,776 cubic yards
Cement content	48,000 carloads
Excavation for the dam, common	20,535,422 cubic yards
Rock excavation	2,095,557 cubic yards
Maximum concrete, 1 month	536,264 cubic yards

POWER PLANT

Turbines	18 of 160,000 horsepower each 3 of 14,000 horsepower each
Generators	18 of 108,000 kilowatts each 3 of 10,000 kilowatts each
Total nameplate capacity	1,974,000 kilowatts
Record hourly output (in 1952)	2,309,000 kilowatts

FRANKLIN D. ROOSEVELT LAKE

Area	85,000 acres
Length	151 miles
Length of shore line	600 miles
Volume	9,700,000 acre-feet
Active capacity	5,165,000 acre-feet
Normal surface elevation above sea level	1,288–1,290 feet
Maximum draw-down	80 feet

COLUMBIA RIVER BASIN

Area	259,000 square miles
Area above Coulee Dam	74,100 square miles
Area in Canada	39,700 square miles
Mean annual runoff above the dam	77,200,000 acre-feet
Maximum required for irrigation	4,000,000 acre-feet
Mean annual flow at the dam	104,150 second-feet
Maximum recorded flow, 1948	637,800 second-feet
Potential water power within the United States	30,000,000 kilowatts

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