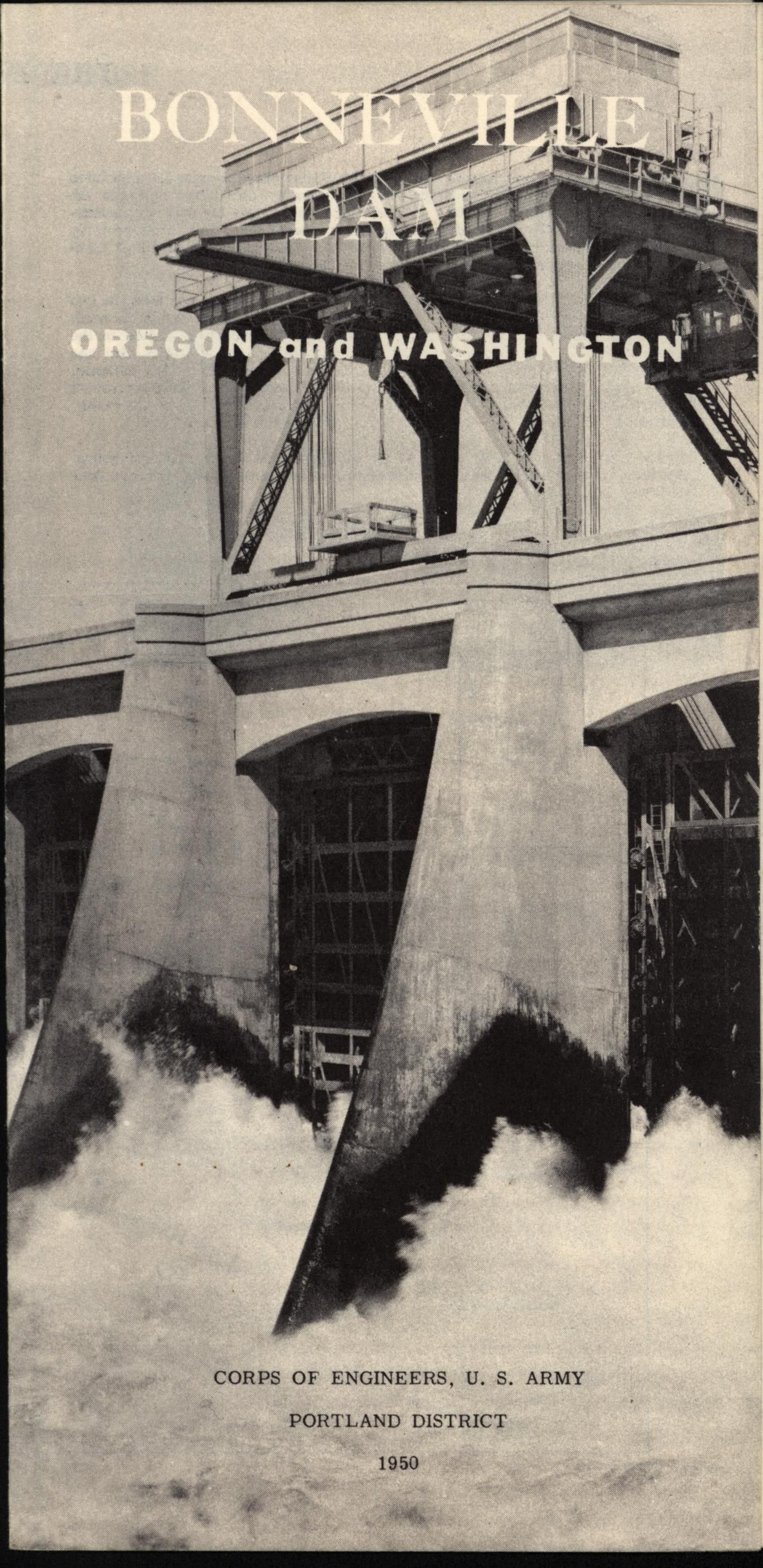
BONNEVILLE DAM

OREGON and WASHINGTON



CORPS OF ENGINEERS, U. S. ARMY

PORTLAND DISTRICT

1950

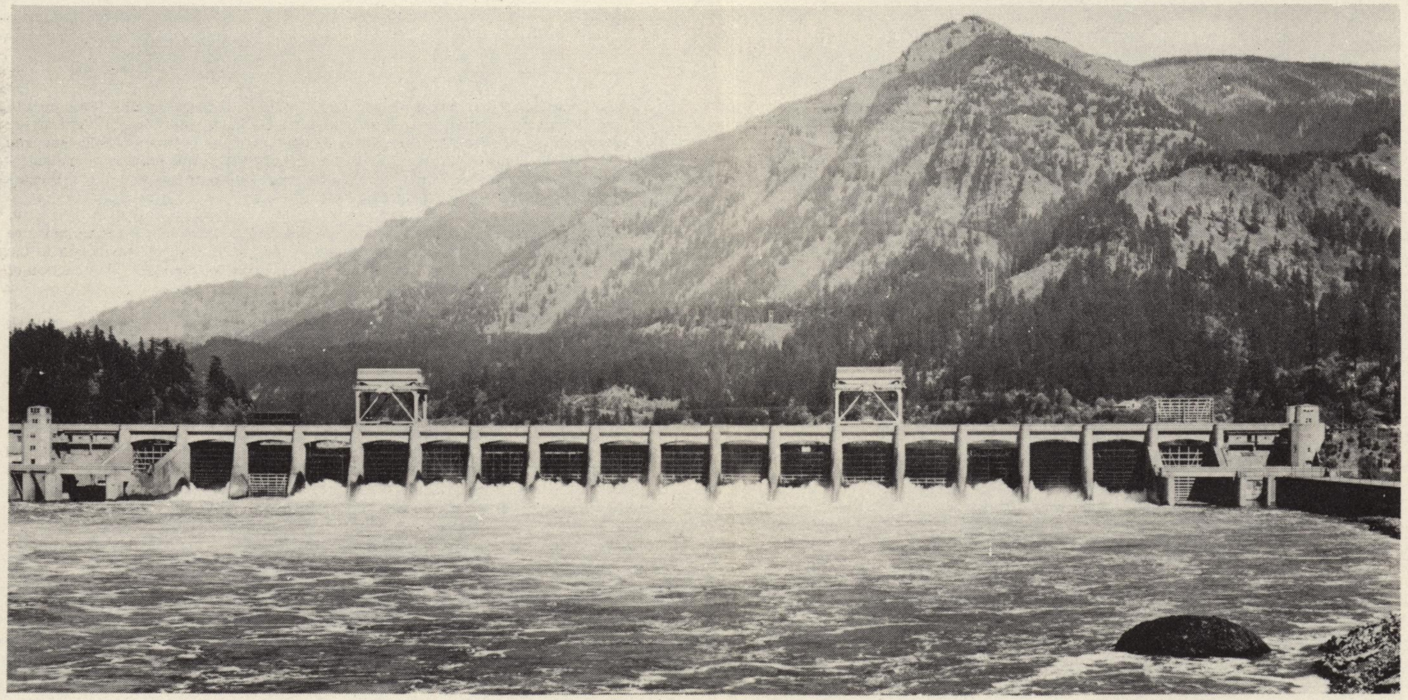
SPILLWAY DAM

The mean flow of the Columbia River at Bonneville is 200,000 cubic feet per second, the minimum flow is about 40,000 c.f.s., and the average annual spring flood flow is approximately 585,000 c.f.s. The low flows, generally lasting only a few days, occur during the winter, and are often accompanied by floating ice. Flood discharges are the result of melting snow near the headwaters of the river and usually reach their peak in June. The maximum flood of record, 1,170,000 c.f.s., occurred in June 1894, and is locally known as the "1894 Flood". The largest flood since the construction of Bonneville Dam occurred in June 1948 with a discharge of 1,020,000 c.f.s.

The river is tidal to the site of Bonneville Dam, a distance of 140 miles from the ocean.

The main function of the spillway dam is to maintain the desired level in the upper pool. A normal elevation of +72.0 ft. m.s.l. is required to provide navigable depths of water from Bonneville to the Celilo Canal near The Dalles, Oregon, and the necessary "head" (difference in elevation between the upper pool and downstream tailwater) on the powerhouse turbines. During periods of flood flow the pool is raised to 82.5 ft. m.s.l. to maintain a minimum of 50 ft. head for power generating purposes. The 18 spillway gates are used to adjust the upper pool level as required and to pass river flow in excess of that used by the powerhouse to generate power.

Protection against the destructive action of the high velocity water issuing from beneath the gates is secured by a double row of baffles and a wide concrete apron at the downstream toe of the dam. The piers have been designed to withstand direct and side pressure resulting from alternate open and closed gates. The gates are constructed of riveted structural steel, with roller bearing wheels, and are mounted in either of the two gate slots constructed in the piers. Each gate is in two sections with special lifting and latching mechanisms so that either the upper half or the whole gate may be moved at one time. They are raised and lowered by either of two 350-ton gantry cranes atop the dam.



Downstream View Of Spillway Dam

FISHWAYS

Bradford Island Fishway

Fish Counting Station

The Columbia River provides spawning grounds for tremendous runs of salmon, trout, and other migratory fish. In the spring and fall, these migratory fish seek passage by Bonneville Dam on their way upstream to their spawning grounds.

To give positive assurance of the upstream passage of the fish, three fishways were constructed; one at each end of the spillway dam, and one across the face of the powerhouse. Each fishway consists of a collecting system, a fishladder, and a pair of fish locks. By-passes were also provided for the downstream migration of fish.

Each fishladder essentially consists of an inclined flume 40 ft. in width in which are installed a series of weirs. These weirs create successive pools each of which is one foot higher than the next one downstream. These fishladders circle around the ends of the dam and powerhouse and permit the adult fish migrating upstream to reach the higher water level above the dam. The quantity of water flowing down the ladder is regulated to induce the fish to swim rather than jump from one pool to another. Fish counting stations are operated at each fish ladder to observe the success of the fishways and to obtain data necessary for the successful conservation of fish in connection with dams yet to be built on the Columbia River.

Fish locks are similar in operation to the navigation lock. The fish are admitted to the lock when the water level therein is the same as the tailwater. The lower gate is then closed and the chamber is filled with water to the upper pool level. The fish rise and subsequently leave the lock chamber through an upstream gate. A slanting grating is lifted by a hoisting mechanism during the filling operation to insure that the fish actually do leave the lock before the next operation. Because the fishladders have proven entirely satisfactory in passing the migratory fish over Bonneville, the operation of the fish locks has not been necessary and they are held in readiness for use in emergencies.

STATISTICAL DATA

Spillway Dam

over-all length	1,450 ft.
width of gravity section	132 ft.
width of baffle deck	67 ft.
width of apron	approx. 80 ft.
crest elevation	24 ft. m.s.l.
height above lowest bedrock	197 ft.
overflow section length	1,070 ft.
design capacity	1,600,000 c.f.s.
gates	12 - 50 ft. wide, 50 ft. high
	6 - 50 ft. wide, 60 ft. high
piers	17 - 10 ft. wide
normal pool elevation	72.0 ft. m.s.l.
maximum pool elevation	82.5 ft. m.s.l.
gantrys	2 - 350 ton capacity
roadway width and elevation	29 ft., 97 ft. m.s.l.

Powerhouse

length	1,027 ft.
width	190 ft.
height of roof above lowest bedrock	190 ft.
station service unit	4,000 k.w. 0.8 power factor
number of hydro-generating units	2 - 43,200 k.w. 0.9 power factor
	8 - 54,000 k.w. 0.9 power factor
total rated capacity	518,400 k.w. 0.9 power factor
generators	3 phase, 60 cycle, 13,800 volts
generator housing diameter	48 ft.
transmission voltage	115,000 and 230,000
Kaplan type turbines	2 - 66,000 h.p. 50-ft. head
	8 - 74,000 h.p. 60-ft. head
discharge per turbine	13,000 c.f.s.
propeller	5 blades, 23 ft. 4 in. diam.
speed	75 r.p.m.
thrust bearing load	approx. 3,000,000 lbs.
wicket gates	20 - 4 ft. wide, 9.5 ft. high

Navigation Lock

length	500 ft.
width	76 ft.
lift	30 to 70 ft.
capacity	approx. 8000-ton ship
downstream miter gates	2 - 102 ft. high, wt. 525 tons
upstream miter gates	2 - 45 ft. high, wt. 232 tons
filling and emptying ports	41 - 4 ft. diam.
filling and emptying valves	4 - 7 ft. x 11.5 ft., tainter type
main culvert	14 ft. diam.
filling and emptying time	approx. 15 min.
depth over lower miter still at normal low water	24 ft.

Fishways

Fishladders:	
number	3
length: Washington Shore	1,312 ft.
Bradford Island	1,312 ft.
width: Main Bradford Island	40 ft.
length of pools between transverse weirs	16 ft.
vertical drop between successive pools	1 ft.
Fishlocks:	
number	6
length	30 ft.
width	20 ft.
height	105 ft.
Fingerling By-Passes (for downstream migrants):	
number	6
width	4-8 ft.

THE PROJECT

The Columbia River has its source in the Rocky Mountains in the Dominion of Canada and, after flowing some 460 miles, enters the United States in the northeastern corner of the State of Washington. It crosses the state in a southerly direction to the mouth of the Snake River, near Pasco, then turns westerly to form the boundary of Oregon and Washington. The river has a length of 1,210 miles and drainage area of 259,000 square miles.

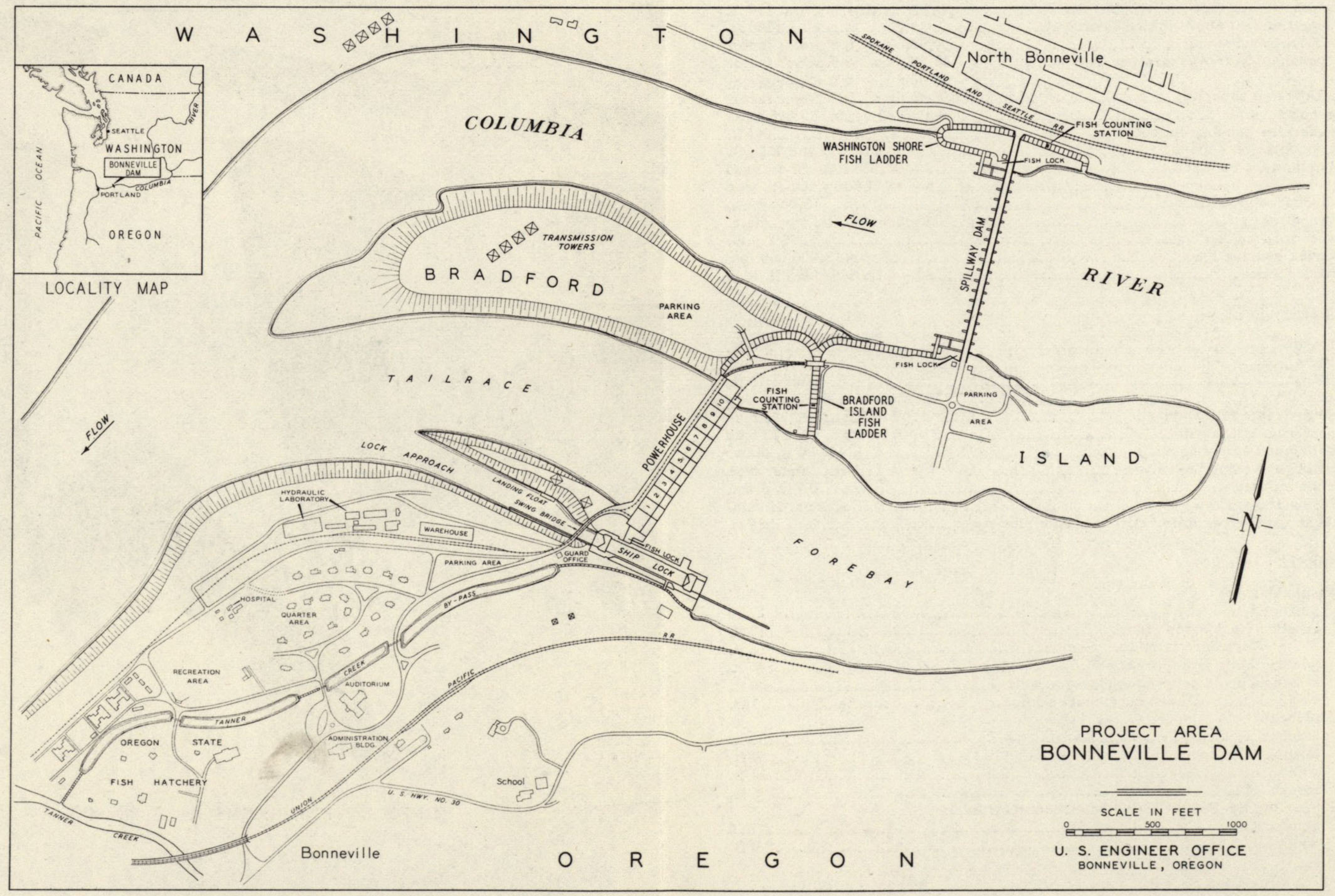
At the site of Bonneville Dam, the Columbia River flows westerly in two channels separated by Bradford Island. The spillway dam is located in the north or main channel, and the powerhouse and navigation lock are located in the south channel. Fishladders are located at each end of the spillway dam and across the downstream face of the powerhouse. An administration building, auditorium, warehouse, and permanent residences are a part of the Government reservation. The Bonneville Hydraulic Laboratory is also located on the reservation.

The project is open daily to the public for inspection during daylight hours. Parking areas are provided for visitors near the navigation lock, fishways, and spillway dam.

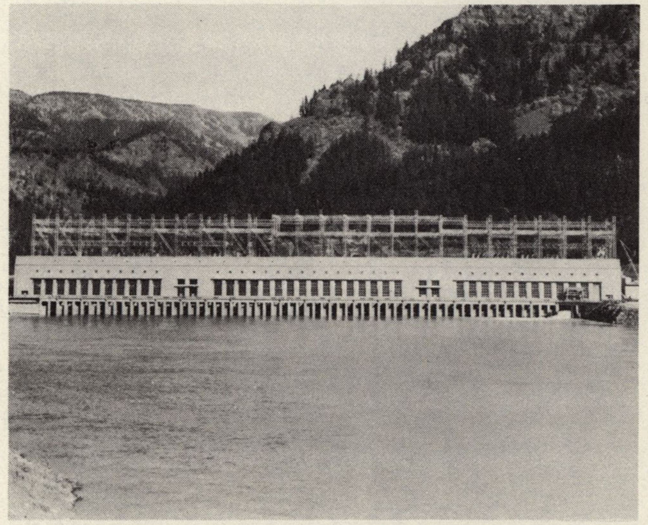
Improvement of the Columbia River at Bonneville, Oregon was undertaken on September 30, 1933 under the provisions of the National Recovery Act; formal authorization by Congress was made under the River and Harbor Act approved August 30, 1935. The project is located on the Columbia River about 40 miles east of Portland, Oregon, and consists of a spillway dam, powerhouse, navigation lock, and fishways. The total construction cost of the project amounts to approximately $82,840,000 of which 48% represents power facilities, 35% spillway dam, 7% navigation lock, and 9% fishways.

The entire project was constructed and is being maintained and operated under the direction of the Secretary of the Army and the supervision of the Chief of Engineers, Department of the Army. Immediate supervision of the project is under the direction of the District Engineer, Corps of Engineers, 628 Pittock Block, Portland 5, Oregon. A Corps of Engineers Sub-Office is located at the Dam.

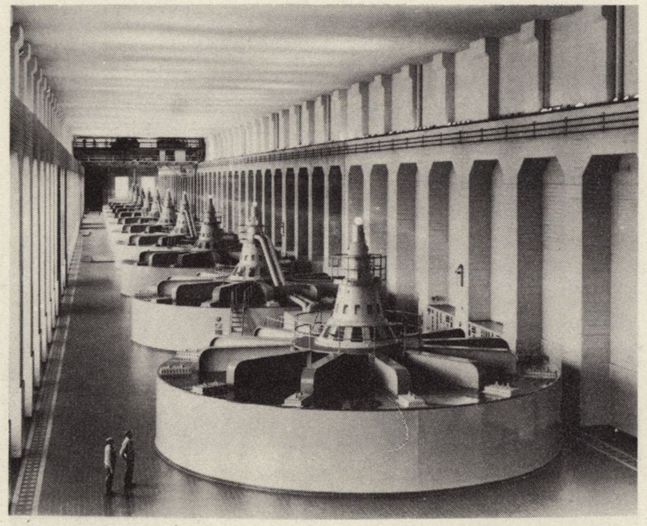
The transmission and sale of electric energy generated at Bonneville is under the direction of the Secretary of Interior and the supervision of the Bonneville Power Administration.



POWERHOUSE



Downstream View Of Powerhouse



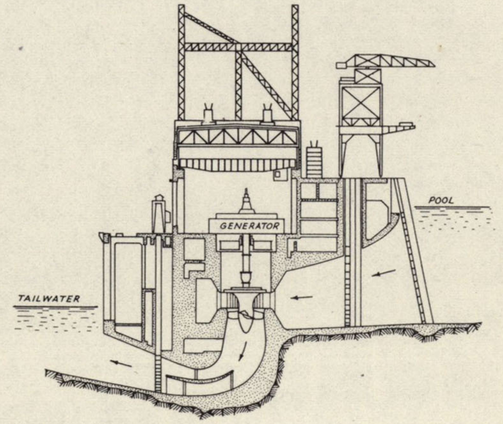
Generator Room

The powerhouse, located between Bradford Island and the Oregon shore, is founded on hard andesite rock which was excavated to a maximum depth of 93 ft. below sea level. Two rock and earth fill cofferdams, one upstream and the other downstream, protected the area from normal river flows during construction of the substructure. The original construction provided for the completion of the substructure to accomodate six generating units and a station service unit. With the advent of World War II, electric energy demand for war industries rapidly increased, so excavation and construction was immediately put under way to provide for the additional four generating units ultimately planned. The final installation was completed in record time by December 1943, making a total of ten main generating units and a station service unit.

Each generating unit consists of a hydraulic turbine driven generator with auxiliary controlling mechanism. The turbines are of the Kaplan adjustable-blade propeller type. Water is admitted to the turbines by means of 20 wicket gates for each unit; these gates are similar in operation to vertical Venetian blinds. As electric loads increase on the units, the automatic governor control opens the wicket gates thereby permitting more water to pass through the turbine. Simultaneously with the opening of the wicket gates the adjustable propeller blades are moved to a steeper angle, thereby holding the turbine to its maximum efficiency. In a reverse manner the governor operates for decreasing loads.

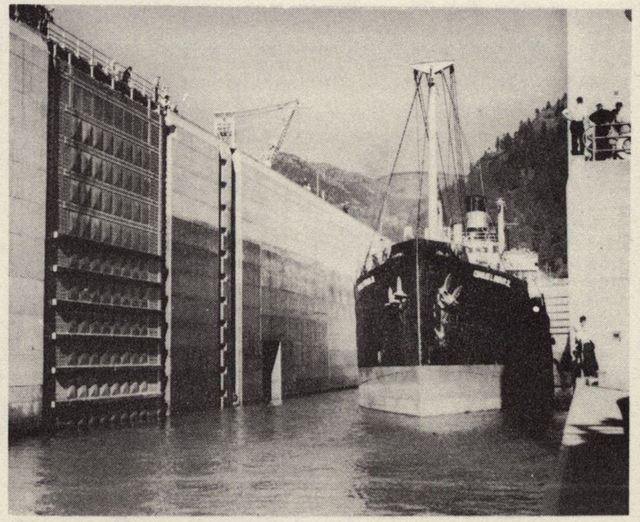
The main generators are located on the ground-level floor of the powerhouse. They are of the vertical shaft type, and are directly connected to the turbine shaft. Below the generator rotor is a single thrust bearing that carries the entire weight of the rotating parts of the generator and turbine, and the hydraulic thrust developed on the turbine propeller blades. The generating units may be controlled individually from adjacent control panels, but over-all control of the station is from the master control room. The operator on duty coordinates all activities within the powerhouse and connections with the transmission system.

On the +90 deck of the upstream face of the powerhouse are located the transformers that step up the generated voltage of 13,800 to 115,000 and 230,000 volts for transmission. The high tension switching equipment on the roof of the powerhouse is where the power generated is delivered to the transmission lines of the Bonneville Power Administration.



Cross Section Of Powerhouse

NAVIGATION LOCK



S. S. "Charles L. Wheeler, Jr.", Leaving Shiplock On Way Downstream July 1938

The Columbia River has a project depth of 35 ft. from its mouth to the mouth of the Willamette River near Portland, and 30 ft. to the City of Vancouver, Washington. The work of dredging a 27-foot channel between Vancouver and Bonneville has been completed with the exception of a few places where sufficient depth is maintained for barge traffic only. Depth of the pool above Bonneville Dam to The Dalles, Oregon is 30 ft. or over.

Excavation for the navigation lock at Bonneville Dam was made in andesite rock, and the exposed wall surfaces were faced with concrete anchored to the rock. The additional height required was secured by concrete construction of both gravity and counterfort type walls.

In "locking through" a ship going upstream, the upstream gates are first closed, then the lock chamber is emptied to the level of the river downstream by means of the two emptying valves located in the west end of the lock walls. The downstream gates are then opened and the ship signaled to enter the lock and tie up to the floating mooring bits recessed in the lock walls. The downstream gates are closed, and the chamber filled to the upper pool level by means of the filling valves located in the east end of the lock walls. Upon opening the upstream gates, the ship may pass out of the lock into the Bonneville pool and proceed upstream. Downstream passage of shipping is effected in a reverse manner. All machinery is electrically driven and may be controlled from stations located at either end of the north side of the lock.

During the ten year period, 1940 to 1949 inclusive, the average annual shipping passing through the lock was 924,918 tons.

Army-Port. Dist., Oreg.