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BIG QUALICUM RIVER
FISHERIES DEVELOPMENT PROJECT

Department of Fisheries, Canada

Vancouver, B. C.

April, 1961

THE BIG QUALICUM RIVER
FISHERIES DEVELOPMENT PROJECT

INTRODUCTION

Studies of the Big Qualicum River were started in 1957 to determine whether it would be economically feasible to provide controlled flows to increase the production of Pacific salmon and trout in the system. The studies were initially directed to making a preliminary estimate of the cost of the project and to determining the benefits to the fishery. The engineering investigation also included the possibility of developing a small block of hydroelectric power in conjunction with flow control; however, it was found that production of power in conjunction with flow control would not be economical at the present. This feature of the original proposal will therefore not be dealt with further in this report.

The following report describes the Big Qualicum River watershed, the reasons for selecting the site, a description of the proposed project and an outline of the costs and benefits of the project. The design of the Big Qualicum River Project was commenced in 1959 after preliminary engineering and biological studies indicated that the proposal was economically feasible.

DESCRIPTION OF THE WATERSHED

The Big Qualicum River is located on Vancouver Island about midway between the cities of Nanaimo and Courtenay. The headwaters of the river lie in the mountainous central part of the island, and the river drains in an easterly direction, emptying into the Strait of Georgia (See figure 1).

The total drainage area of the Big Qualicum River is 58 square miles, with the largest portion, 42.5 square miles, draining into Horne Lake. The balance of 15.5 square miles drains directly into the river over its length of almost 8 miles between Horne Lake and the sea. Only one major tributary, Hunts Creek, enters the river in this length. Hunts Creek has a drainage area of 7.0 square miles, and discharges into the Big Qualicum approximately 2.5 miles above tidewater.

Most of the watershed area lies in the wooded mountains of the Beaufort Range, which has an average elevation of approximately 3,000 feet and is snow-capped in winter. The sides of the valleys at the headwaters of both Hunts Creek and the Big Qualicum above Horne Lake are sharply inclined with the result that heavy runoffs of short duration occur during periods of heavy precipitation. The maximum recorded discharge near the mouth of the Big Qualicum is 7,080, cfs, which occurred in February, 1918. The minimum discharge of 15 cfs has been recorded during the spawning season several times over the period of record since 1913. Hunts Creek has a recorded minimum discharge of less than 5 cfs and an estimated maximum flood discharge of 2500 cfs.

Below the outlet of Horne Lake, the Big Qualicum River enters a narrow canyon and flows for three-quarters of a mile over a succession of rapids and falls. The river drops a total of approximately 190 feet in this length. Over the remaining seven miles to the ocean it flows through a progressively wider valley,

and its profile has a fairly uniform slope of approximately 6 in 1,000 except for a few short lengths where the gradient is somewhat steeper.

Horne Lake, which lies at an elevation of 392 feet above sea level, is about four miles long and three-quarters of a mile wide. Its total surface area is three square miles. Soundings have indicated that the maximum depth of the lake is 180 feet and also that the lake is divided by two underwater ridges into three basins. One ridge, with its lowest point at elevation 340 feet, runs east-to-west across a narrow part of the lake near where the Big Qualicum River enters the head of the lake. Another ridge, with a low point at elevation 326 feet, runs approximately north-to-south through an island near the outlet of the lake. The lake is therefore divided into three basins as noted, with a small one at the inlet, another small one at the outlet, and the main basin between.

Because of the insurmountable falls and rapids downstream from Horne Lake, all salmon spawning is confined to the seven miles of river between the falls and the ocean. A small number of salmon also spawn in the lower reaches of Hunts Creek.

BASIS FOR SELECTION OF SITE

The Big Qualicum River system was selected as the possible site for a controlled flow project after studying several other river systems. While some of the other river systems had merit as sites for such a project, the Big Qualicum was considered

to be superior because it combined all of the following advantages:

1. Horne Lake appeared to be ideally situated to act as a storage reservoir to maintain the flows required in the river and to prevent flood flows from damaging the spawning beds.

2. It also appeared to be possible to design the outlet works at Horne Lake in such a manner that a certain amount of temperature control would be possible in the river downstream.

3. In the more than 7-mile length of the Big Qualicum River below Horne Lake there was only one major tributary likely to cause flooding, and it appeared that this tributary, Hunts Creek, could be diverted from the Big Qualicum River at reasonable cost.

4. The lakeshore property surrounding Horne Lake was entirely unimproved and, therefore, no excessive costs for development of storage were anticipated.

5. Access by road and rail to the area was very good compared to other areas in B. C.

6. The river supported native runs of all species of Pacific salmon except sockeye, consequently the success of the project would not depend on the establishment of a species not indigenous to the watershed.

7. The Big Qualicum River is also a major producer of Pacific salmon and trout. The average estimated spawning escapement from 1950 - 1955 inclusive was 1000 chinook, 3500 coho, 35,000 chum, 300 pink salmon and numbers of steelhead, rainbow and cutthroat trout.

8. There was direct evidence to show that the extreme variation in flow in the Big Qualicum River had resulted in a low percentage fry survival.

As the engineering surveys progressed these advantages were confirmed. A preliminary cost estimate prepared early in the investigation indicated that the desired degree of flow control and temperature regulation could be accomplished at a cost of approximately \$1,000,000. The biological surveys and analysis indicated that the benefits would be commensurate with this expenditure. Therefore detailed planning and design was proceeded with as rapidly as possible.

Plans and specifications for the project were completed late in 1960, and a construction schedule was recommended which would entail a start on the general contract in April, 1961 and completion in September, 1962.

DESCRIPTION OF THE PROJECT

1. Horne Lake Dam and Control Works

The proposed outlet control works for regulating the flows from Horne Lake include a 98-foot deep concrete-lined vertical shaft with three separate intakes from the lake; an 8-foot diameter horseshoe-shaped tunnel, approximately 2000 feet long, extending from the base of the shaft approximately 70 feet below the present normal level of the lake, downstream to a point on the north bank of the Big Qualicum River at the base of the second falls; a control works at the downstream end

of the tunnel: and an earthfill dam near the outlet of Horne Lake. The control works for flow regulation will consist of two motor-operated 48-inch hollow-cone valves.

The concrete-lined intake shaft will be square in plan with outside dimensions of 18'-6". It will be set in solid rock as shown in figure 3. The high-level intake will be an open cut channel with a floor elevation at 373.5 feet; the intermediate intake will be a seven-foot diameter tunnel with an invert elevation of 350.5; and the low-level intake will also be a tunnel, with an invert elevation of 323.5 feet. The low-level intake will be fitted with a seven foot diameter wood-stave pipe, extending down along the lake bottom for a distance of approximately 90 feet to an invert elevation of 306.5 feet. Flow into each intake will be controlled by a separate gate, so that water can be taken from any one of the three levels or mixed to the desired proportions from all three levels. This particular feature is essential in order to maintain the desired degree of temperature control downstream. The intake shaft also contains another gate for dewatering the tunnel should repairs to the unlined tunnel be required at some future date.

An earthfill dam, with crest at elevation 420 feet, 28 feet above the normal elevation of Horne Lake, will be constructed across the present river channel downstream of the lake outlet to provide sufficient storage for flood control. A

spillway channel was provided in rock foundation at the left-bank end of the dam for emergency use in case an extremely heavy flood necessitates raising the water surface above the spillway crest level of 412.30. It is extremely unlikely, however, that any spillage over this crest will be necessary.

2. Hunts Creek Dam and Flood Channel

Hunts Creek, the major tributary flows into the Big Qualicum River approximately four miles downstream from the outlet of Horne Lake. To maintain regulated flows in the Big Qualicum River below this point, a means of controlling Hunts Creek runoff was required. Due to the irregularity of flow and the lack of a suitable storage basin, control by storage reservoir was not practical. An open-cut flood channel 2 1/2 miles long was therefore proposed, with a dam to divert Hunts Creek into the channel near its mouth. The channel will extend along the side of the Big Qualicum River valley and return to the Big Qualicum River just above tidal influence.

The 20-foot high diversion dam on Hunts Creek will be located about one-third of a mile from its mouth. Locating the dam at this point will leave approximately fifteen hundred feet of spawning stream between the damsite and the Big Qualicum River. This is sufficient to accommodate the numbers of salmon which spawn in Hunts Creek. The dam will have a 36-inch diameter culvert fitted with a gate to control the flow over this spawning area. The culvert will normally be set to pass all flows in

Hunts Creek less than 20 cfs, but can be regulated to pass flows up to a maximum of 50 cfs. The culvert will be so constructed that no fish will be able to pass upstream beyond this point.

The flood channel, which will carry most of the flow of Hunts Creek, will have an overall length of approximately 2.5 miles with a total fall of 92 feet in this distance. The cross-section will be trapezoidal, with a bottom width of 20 feet, side slopes of 1:2.25, and a minimum depth of 12 feet. The dike separating the flood channel from the Big Qualicum River will have a 15-foot width on the top, which will accommodate a 12-foot single-lane access road. Turnouts will be provided at half-mile intervals. This road will be used to service the flood channel and to provide ready access to the Qualicum River for future improvement work on the spawning grounds.

The flood channel will be located to the north of the Big Qualicum River on the extreme edge of the valley bottom. This location was selected to leave a maximum area of the valley bottom free for future construction of artificial spawning channels. In addition to the diversion dam, three other structures will form part of the flood channel. These will be a concrete flume to carry flood flows under the existing Esquimalt and Nanaimo Railway Bridge, a bridge for the main logging road to Hunts Creek, and a concrete drop structure at the confluence of the flood channel with the Big Qualicum River. The drop structure is necessary to prevent migration of salmon and trout into the flood channel.

This channel can be dry at certain times of the year, and therefore will not be suitable for rearing fish. The concrete drop structure will be 5 feet high with an ogee cross-section, and will have nearly-horizontal steel racks on the downstream face to prevent fish from ascending.

3. Storage, Flow Regulation, and Temperature Control

With the foregoing works it will be possible in nearly all years to maintain a regulated flow of 200 cfs in the Big Qualicum River during the spawning period from August 1 to December 15, and to maintain the discharge for the balance of the year between 150 cfs and 500 cfs.

To accomplish this, a total of 142,000 acre-feet of the storage capacity of Horne Lake will be utilized. The present normal lake level is elevation 392 feet. Capacity below elevation 368 feet will be used to store water to meet minimum flow requirements, while capacity above this level will be set aside for flood control. The storage for flow regulation below elevation 368 totals 52,000 acre-feet, while the flood control storage above this elevation totals 90,000 acre-feet.

This would mean that the surface of Horne Lake could be drawn down to elevation 326, and raised to elevation 412.30, the level of the spillway crest, under the most extreme conditions of drought or flood respectively. During most years, however, it is expected that the reservoir will be operated between elevations 352 and 378.

Location of the invert of the low-level intake at elevation 306.5 feet permits the maximum possible temperature control downstream. Thermal stratification of the lake takes place during the summer, and it will be possible, by use of the low-level intake, to draw water from depths of more than 40 feet in all but the driest years. By this means the temperature of the Big Qualicum River can be lowered by as much as 5° Centigrade in most years during the critical period in August, September and October when pink salmon and the early runs of chinook and chum salmon are spawning. Temperatures in the natural river can reach 20°C. (68°F) during this period, which is sufficiently warm to affect the reproduction of these species in this area.

COSTS AND BENEFITS OF PROJECT

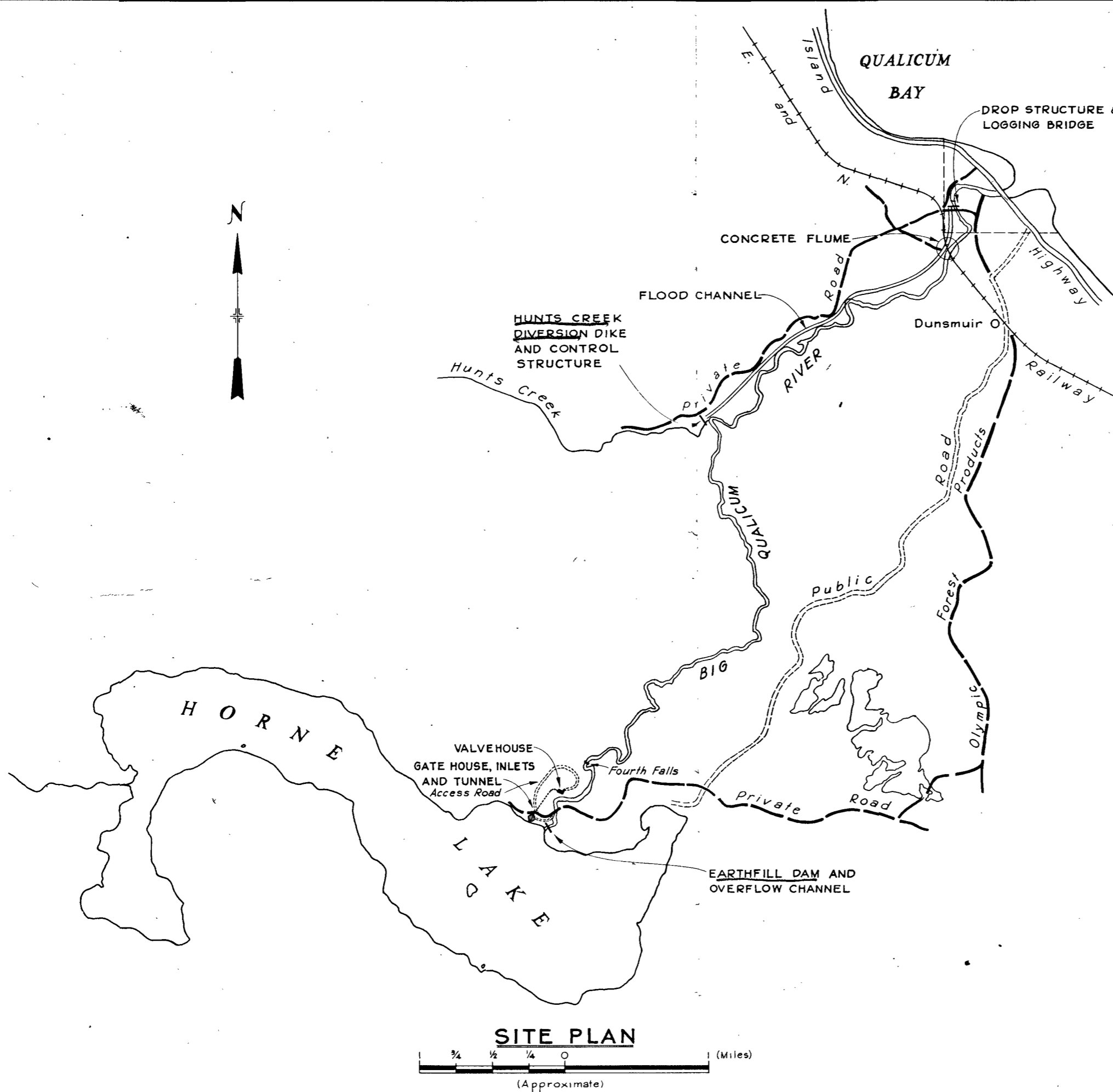
The overall costs of the project as presently planned are as follows:

Engineering (including preliminary report engineering surveys, test drilling, plans, and specifications)	\$	105,500
Property acquisition		90,000
Construction:		
(a) Horne Lake Control Works	\$	615,000
(b) Hunts Creek Flood Channel		435,000
Total for Construction		1,050,000
Total for Project	\$	1,245,500

In any project affecting salmon or other anadromous fish, it is extremely difficult to forecast the effects of changes in the environment on production. This is equally true whether the changes are detrimental ones resulting from an industrial development, or those resulting from an improvement project such as the one described herein. However, the data collected on the Big Qualicum River fishery by the staff of the Fish Culture Branch has been studied by competent biological consultants who have concurred with the conclusions of the Department's biologists that the planned project could return its capital costs in the value of increased production over a period of a few years. This forecast was based on the probability that the ideal flow conditions to be realized after construction would result in production increasing to a point where it would equal in most years the maximum it has only occasionally reached in the past.

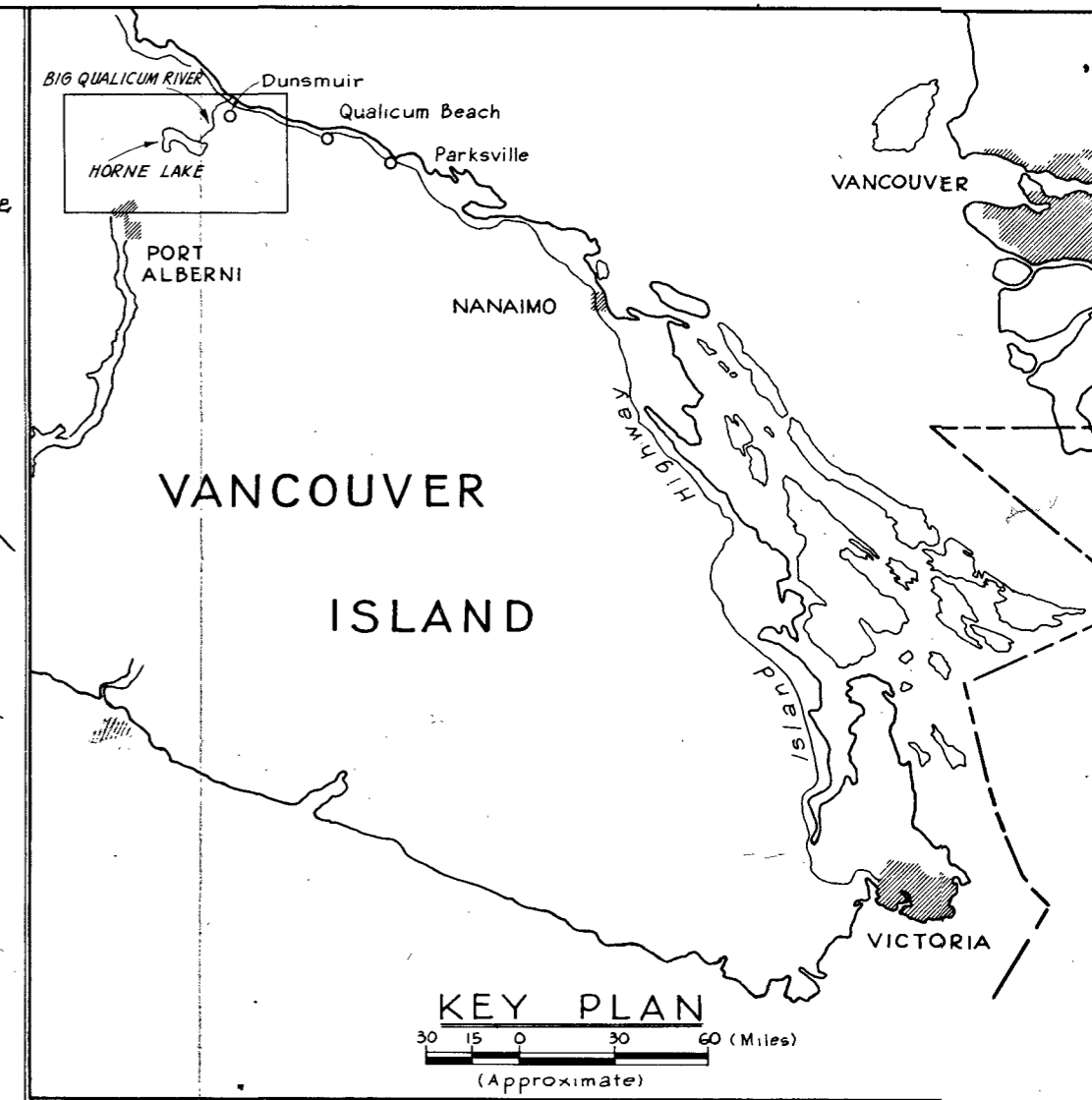
It is believed that this basis of evaluating the project is a conservative one, however, because conditions in the stream will be more stable than they have ever been under natural conditions. Furthermore, it is known that the existing spawning area in the Big Qualicum River is physically capable of accommodating twice the number of salmon which spawned in the maximum year to date (200,000 as compared to the maximum of 100,000). A buildup in the spawning escapement should therefore result in increased numbers available to the fishery over and above those suggested.

If further increases in escapement can be realized, the spawning area in the river can be readily increased at comparatively low cost. Areas of valley bottom are available adjacent to the river where channels can be constructed and the controlled flow passed through to meet additional spawning requirements. In addition it is planned to improve existing spawning grounds in the near future in order to further increase production by increasing the survival of eggs to the fry stage. This will be accomplished by cleaning the gravel in the natural spawning grounds and grading it to standards which have been found most satisfactory in the Department's spawning channel at Robertson Creek and also in the Jones Creek spawning channel. The construction of the flow and temperature control works described in this report are therefore only the first stage of what could be an extensive development project for this system.



SITE PLAN

1/4 1/2 3/4 0 1 (Miles)
(Approximate)

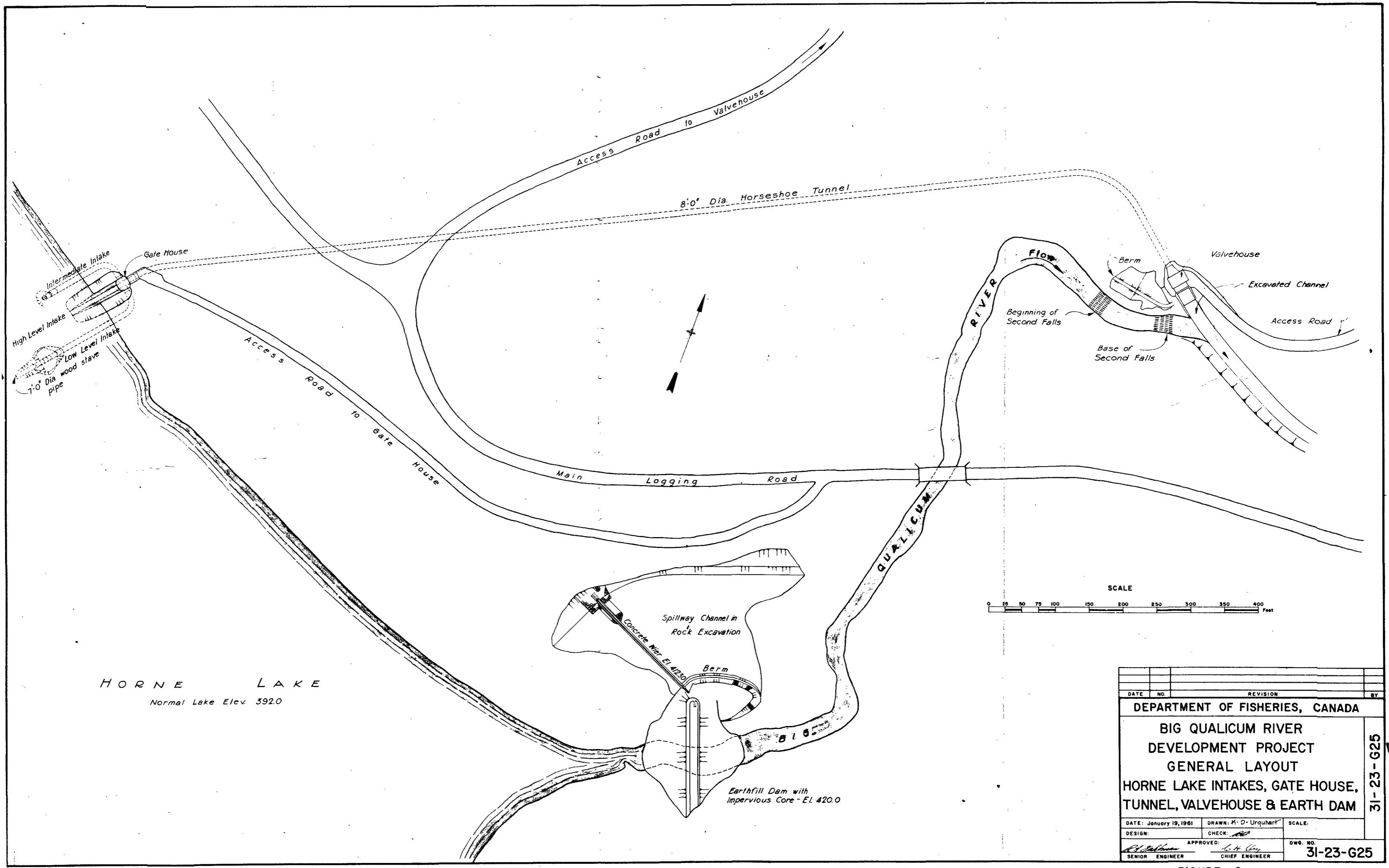


KEY PLAN

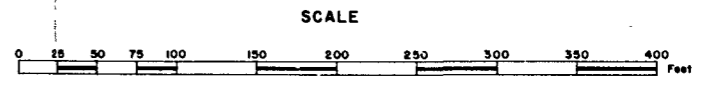
30 15 0 30 60 (Miles)
(Approximate)

DATE	NO.	REVISION	BY
DEPARTMENT OF FISHERIES, CANADA			
BIG QUALICUM RIVER DEVELOPMENT PROJECT			
SITE PLAN AND KEY PLAN			
DATE: February 2, 1961	DESIGN: R. D. Urquhart	CHECK: [Signature]	SCALE: As Shown
DESIGN: R. D. Urquhart	APPROVED: [Signature]	CHECK: [Signature]	DWG. NO. 31-23-G24
SENIOR ENGINEER	CHIEF ENGINEER		

31-23-G24

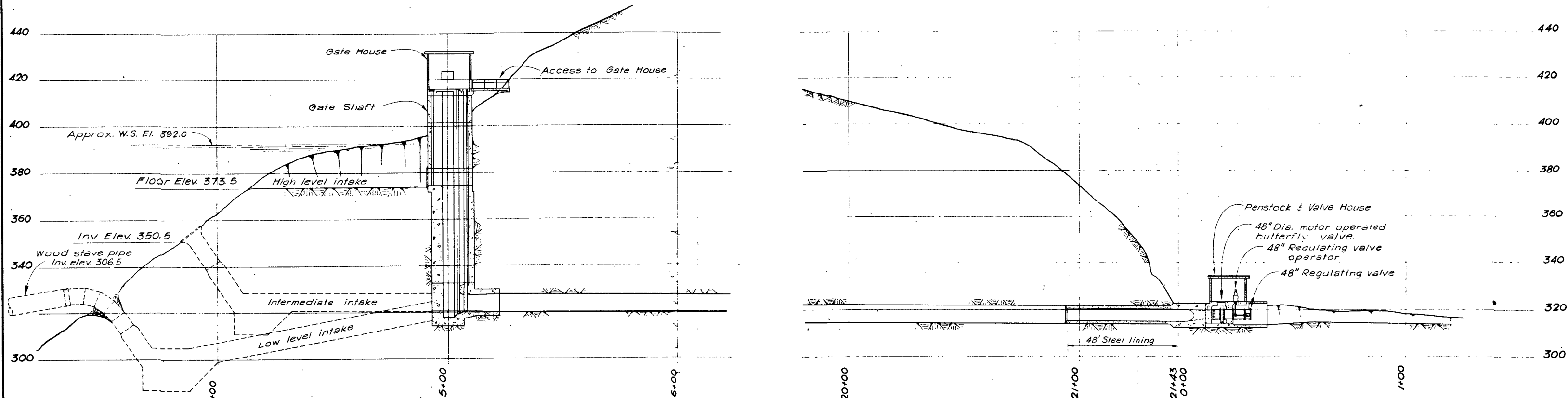


HORNE LAKE
Normal Lake Elev. 392.0



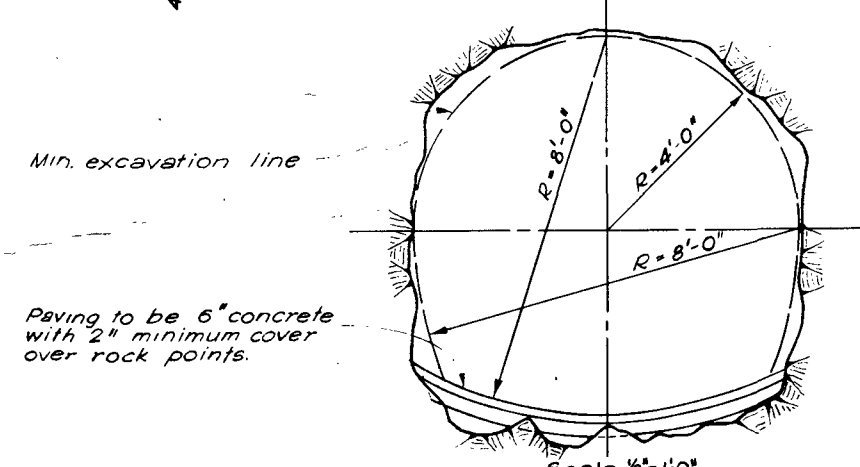
DATE	NO.	REVISION	BY
DEPARTMENT OF FISHERIES, CANADA			
BIG QUALICUM RIVER DEVELOPMENT PROJECT GENERAL LAYOUT HORNE LAKE INTAKES, GATE HOUSE, TUNNEL, VALVEHOUSE & EARTH DAM			
DATE: January 19, 1961	DRAWN: K. D. Urquhart	SCALE:	
DESIGN:	CHECK:		
APPROVED: <i>[Signature]</i>		DWG. NO.	
SENIOR ENGINEER		31-23-G25	

FIGURE 2



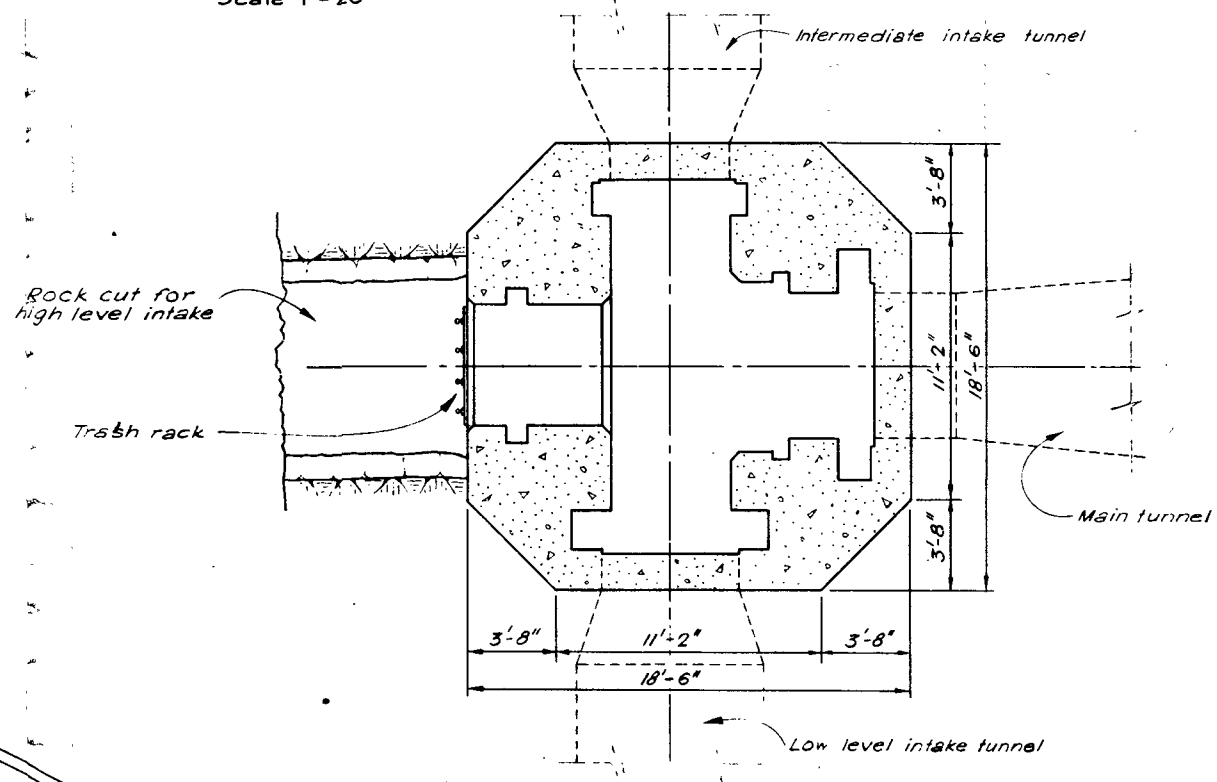
LONGITUDINAL SECTION OF INTAKES, TUNNEL & OUTLET WORKS

Scale 1"=20'



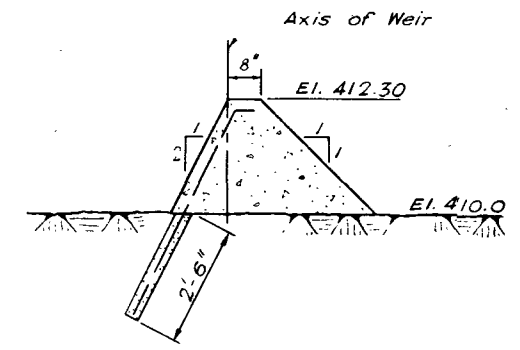
TYPICAL SECTION UNLINED TUNNEL

Scale 1/2"=1'-0"



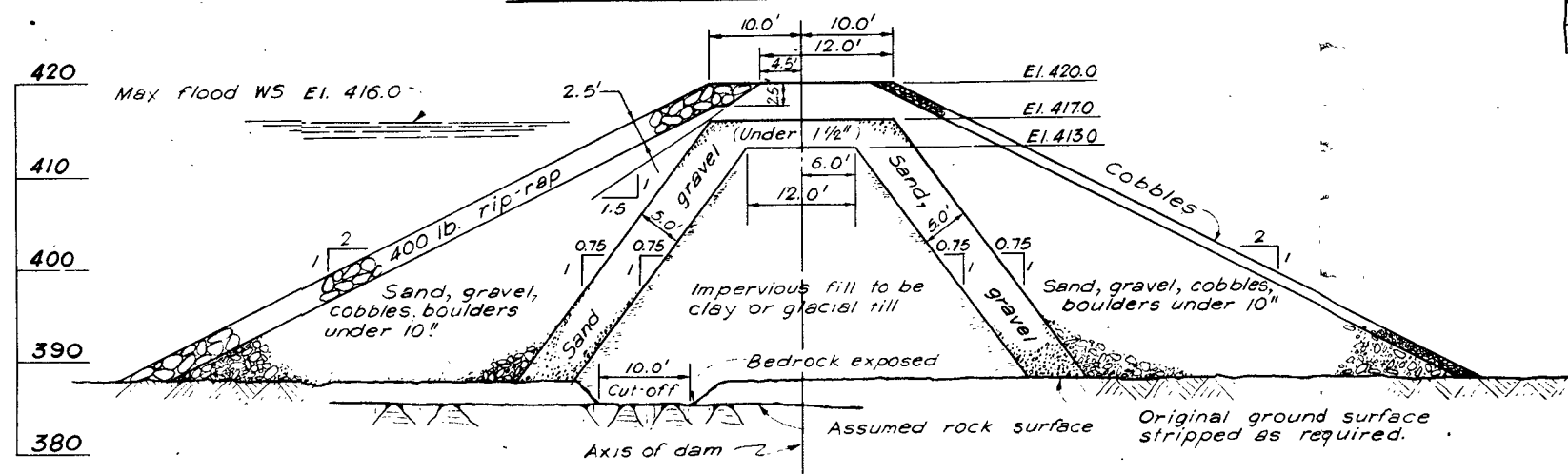
SECTION OF GATE SHAFT SHOWING INTAKES

Scale 1/4"=1'-0"



TYPICAL SECTION OF CONTROL WEIR (IN OVERFLOW CHANNEL)

Scale 1/2"=1'-0"



TYPICAL SECTION OF DAM (NEAR HORNE LAKE OUTLET)

Scale 1"=10'

NOTE: Drawing Not To Scale
Reduced By 50%

DATE	NO.	REVISION	BY
NOV. 21, 1960			

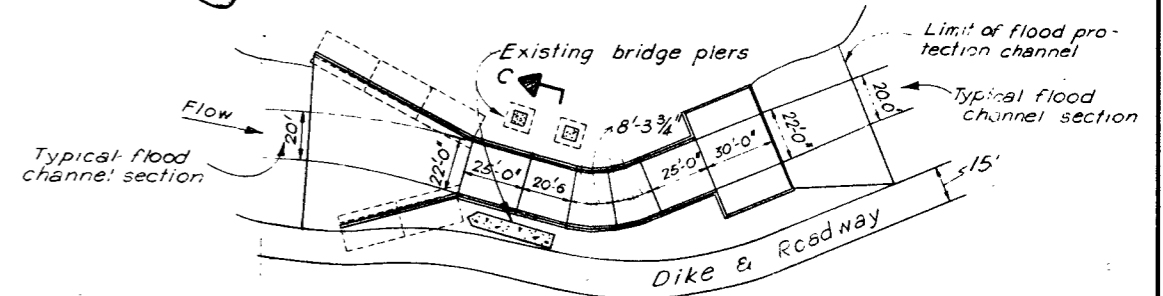
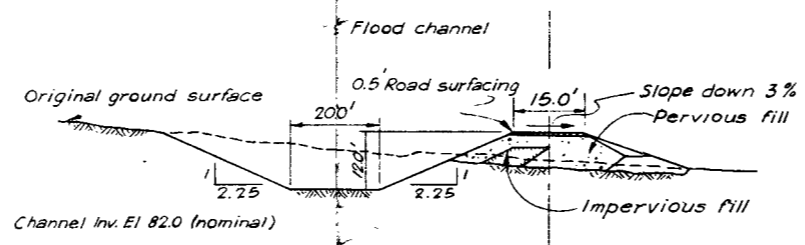
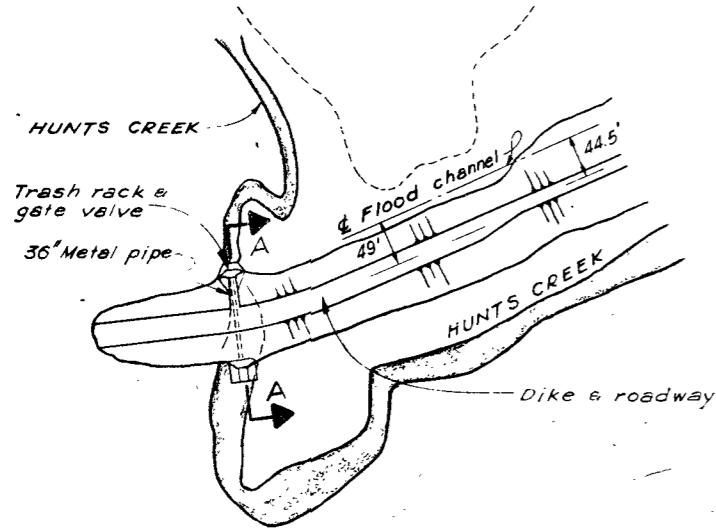
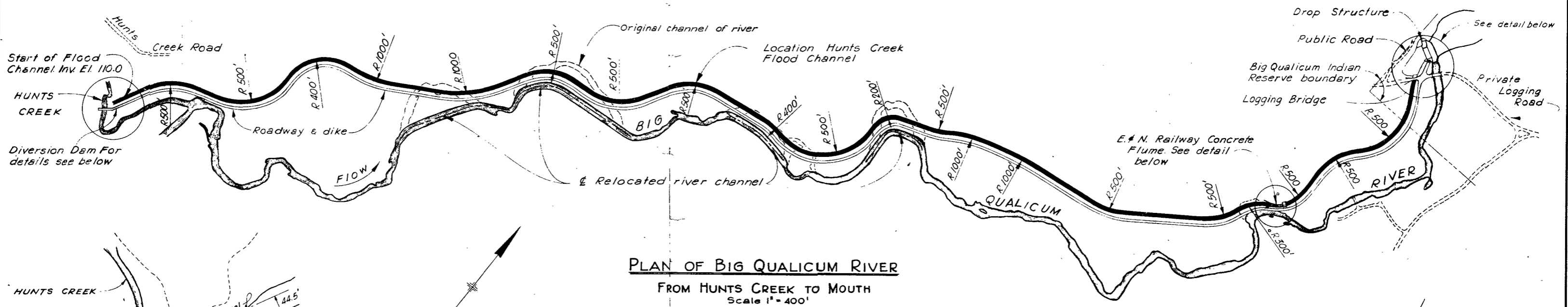
DEPARTMENT OF FISHERIES, CANADA

BIG QUALICUM RIVER
DEVELOPMENT PROJECT

TYPICAL CROSS-SECTION OF
INTAKE AND OUTLET WORKS,
UNLINED TUNNEL, DAM,
SPILLWAY, AND GATE SHAFT

DESIGN: K.D.U.	CHECK: [Signature]	APPROVED: [Signature]	SCALE: As Noted
SENIOR ENGINEER	SENIOR ENGINEER	CHIEF ENGINEER	DWS. NO. 31-23-G26

31-23-G26

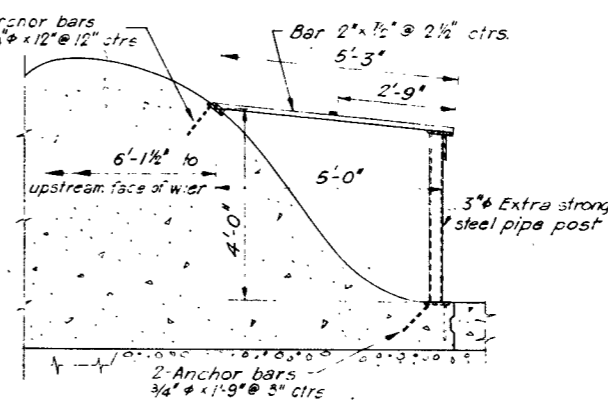
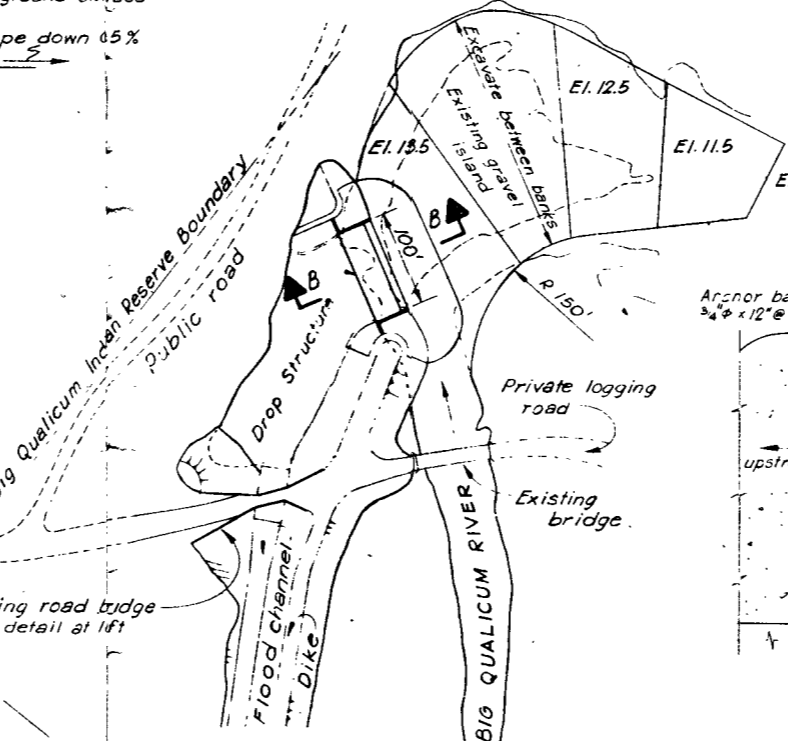
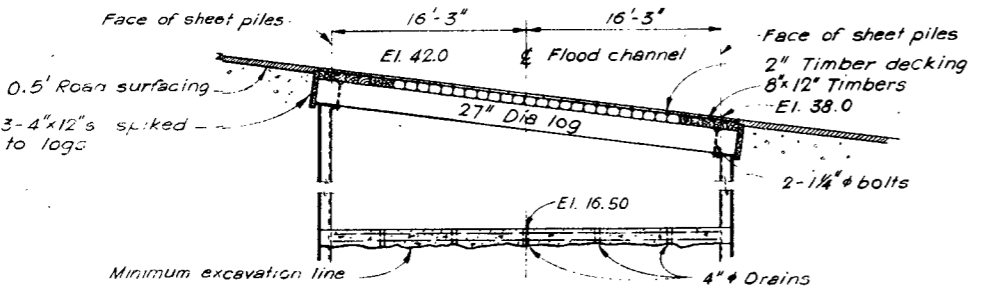
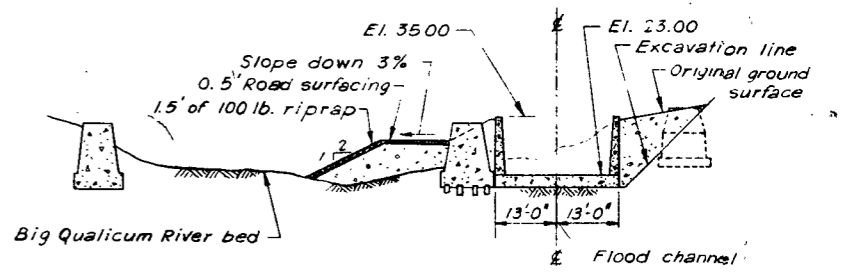
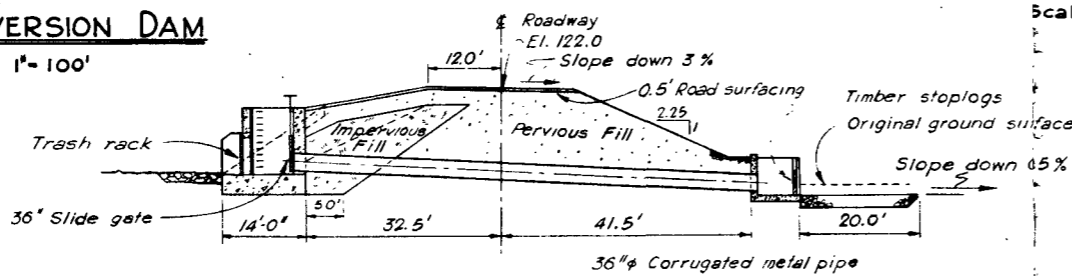


DETAIL OF DIVERSION DAM
Scale 1" = 100'

PLAN OF BIG QUALICUM RIVER
FROM HUNTS CREEK TO MOUTH
Scale 1" = 400'

TYPICAL SECTION OF FLOOD CHANNEL
Scale 1" = 20'

DETAIL OF CONCRETE FLUME
Scale 1" = 40'



SECTION OF LOGGING ROAD BRIDGE
Scale 1/8" = 1'-0'

DETAIL OF DROP STRUCTURE AREA
Scale 1" = 100'

SECTION B-B (SHOWING STEEL RACK)
Scale 1" = 2'-0'

NOTE: Drawing Not To Scale
Reduced By 50%

DATE	NO.	REVISION	BY
DEPARTMENT OF FISHERIES, CANADA			
BIG QUALICUM RIVER DEVELOPMENT PROJECT			
PLAN OF RIVER FROM HUNTS CREEK TO MOUTH			
SHOWING FLOOD CHANNEL AND APPURTENANT STRUCTURES			
DATE: January 19, 1961	DRAWN: A. D. Urquhart	SCALE: As Noted	31-23-G27
DESIGN: [Signature]	CHECK: [Signature]	APPROVED: [Signature]	
SENIOR ENGINEER	CHIEF ENGINEER	DWS. NO. 31-23-G27	