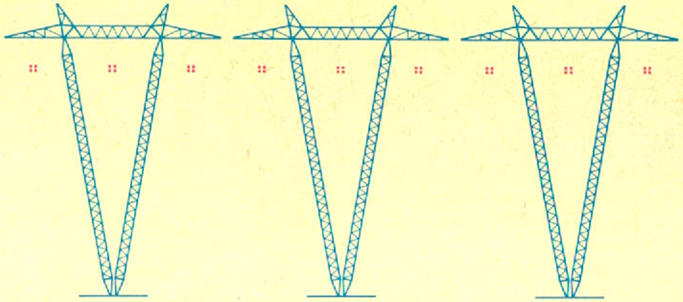
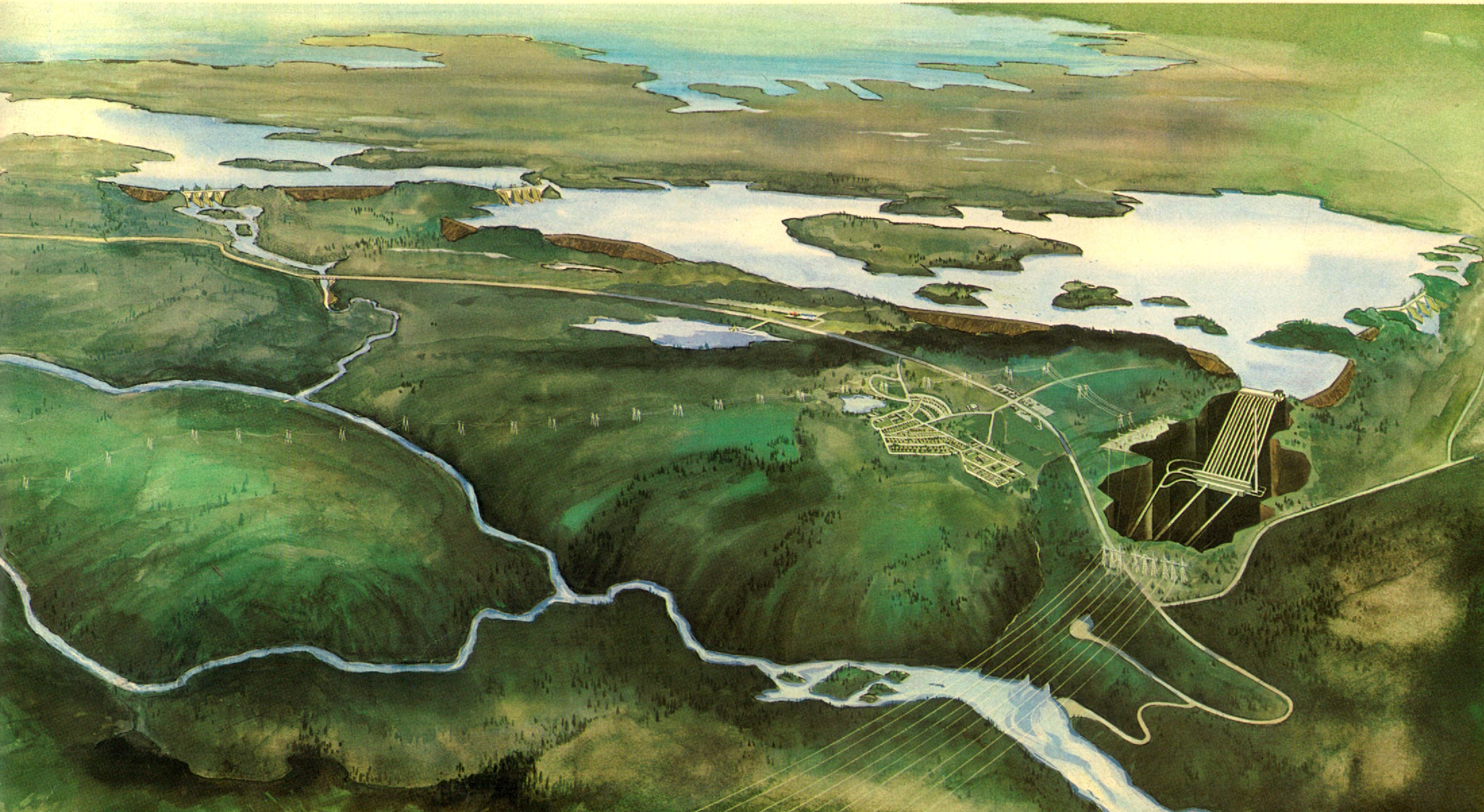
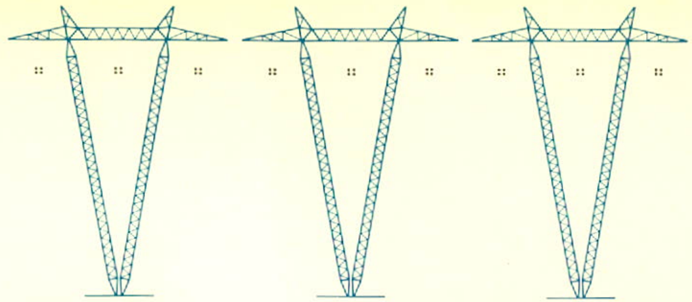
Churchill Falls (Labrador)
Corp. Ltd



Power from Labrador




UNGAVA BAY
HUDSON BAY
CHURCHILL FALLS
200 MILES
400 MILES
600 MILES
800 MILES
1000 MILES
ST. JOHN'S
SEPT-ILES
QUEBEC
SAINT JOHN
HALIFAX
ATLANTIC OCEAN
OTTAWA
MONTREAL
TORONTO
NEW YORK
735 kV Transmission Lines CFLCo
735 kV Transmission Lines HYDRO-QUEBEC
HUDSON BAY DRAINAGE
ATLANTIC DRAINAGE



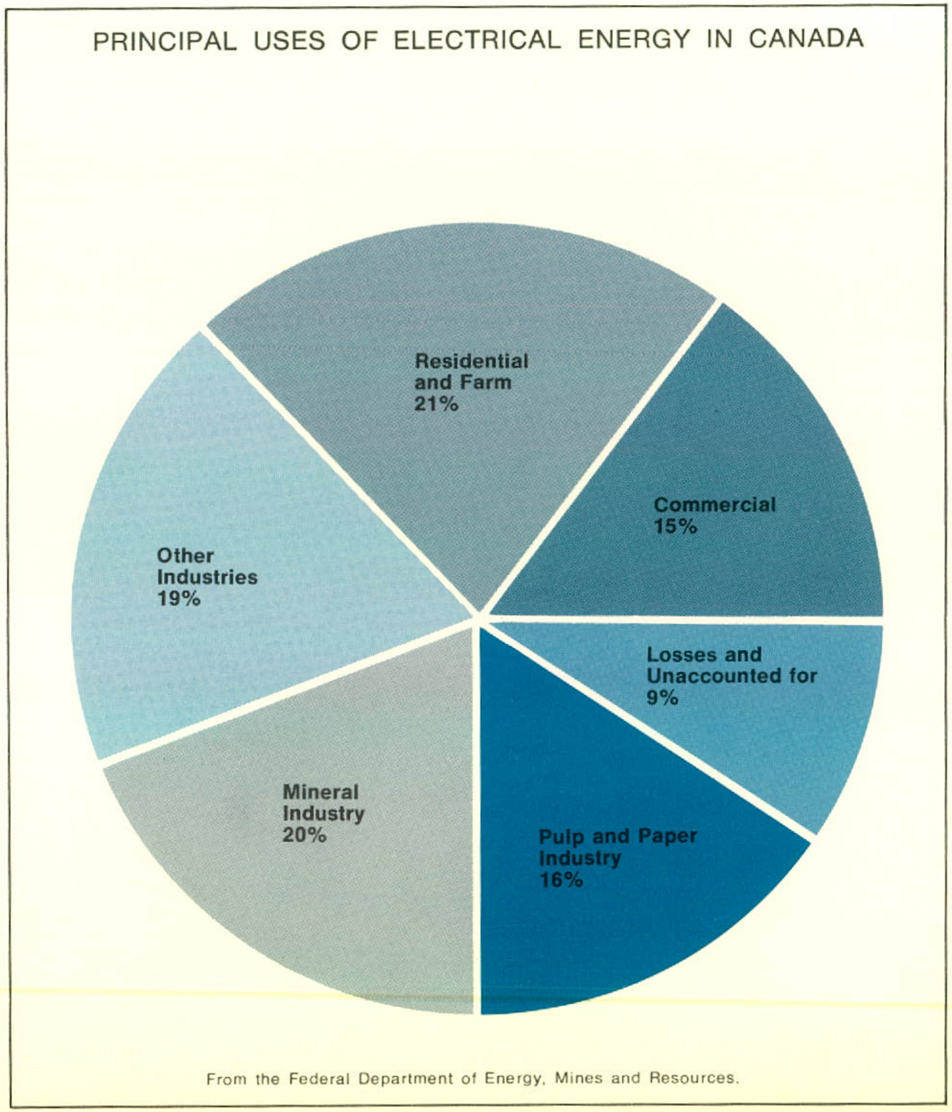
Power from Labrador

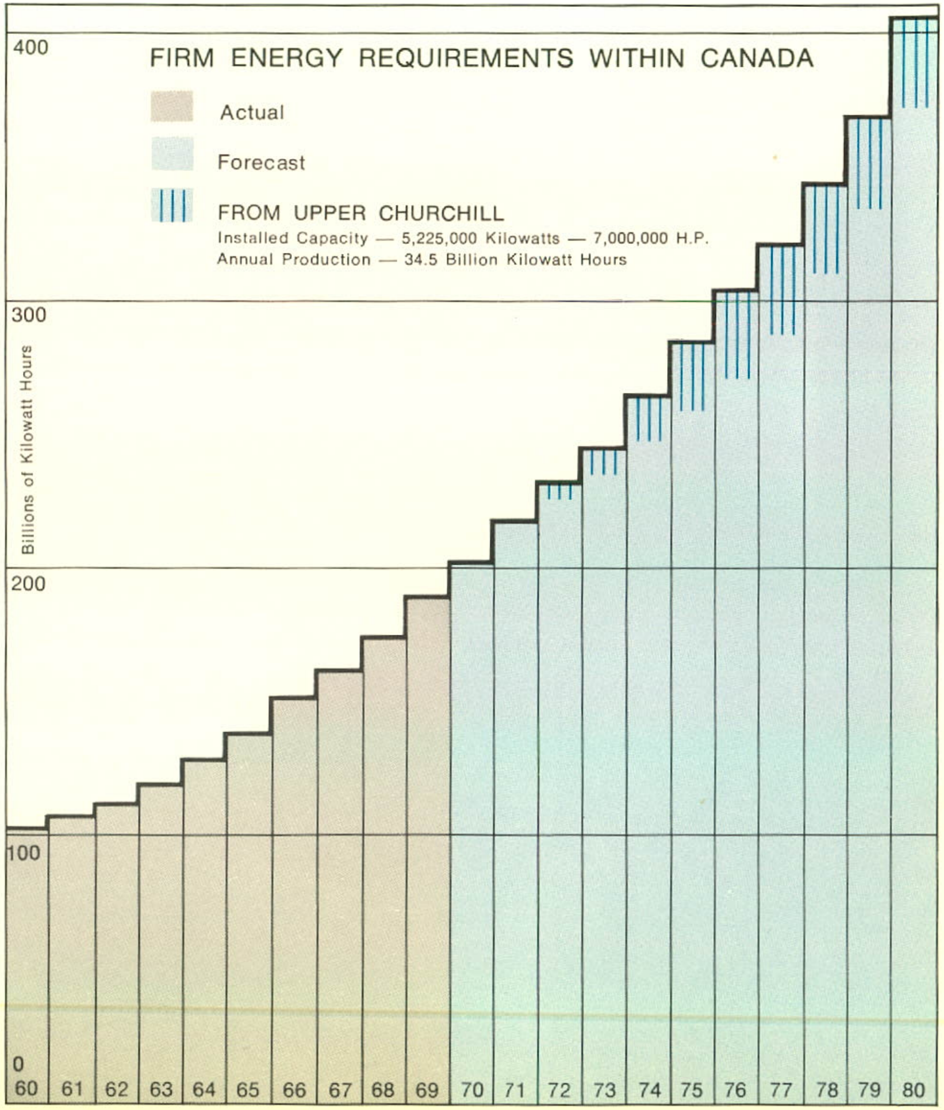
The Churchill Falls Development

*This brochure is dedicated to the memory of
Donald J. McParland, Eric G. Lambert, John F. Lethbridge
Fred E. Ressegieu, J. Herbert Jackson and Arthur J. Cantle*

CHURCHILL FALLS
(LABRADOR) CORPORATION LIMITED

2 Canadian power requirements





The Churchill Falls Power Development has moved steadily from the earlier promise of the Upper Churchill to today's reality of completed financing and advanced construction.

A firm contract for the sale of most of the energy to be produced extends well into the next century.

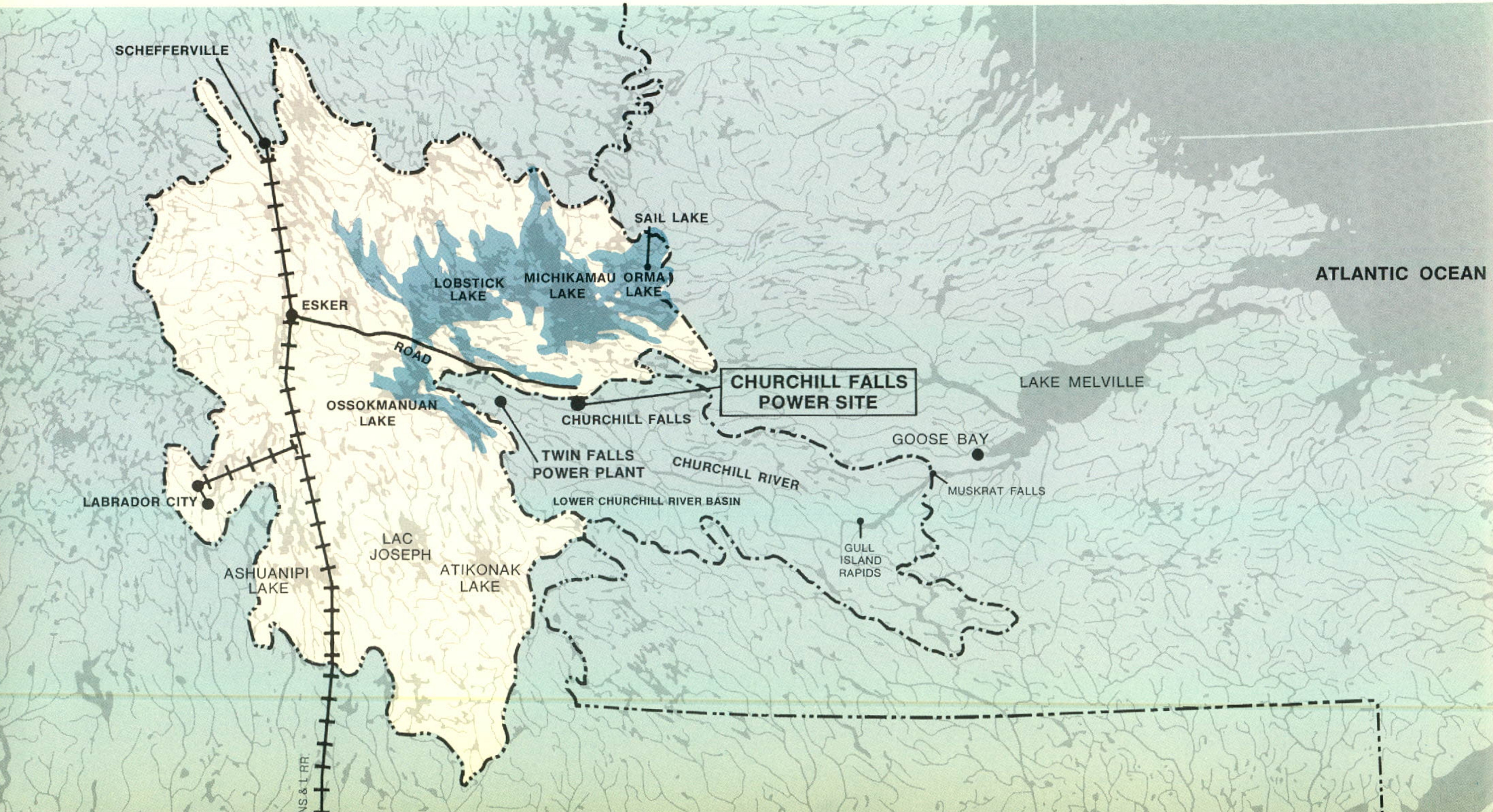
With a capacity of 5,225,000 kilowatts by the mid 1970's, the plant will have an annual production equal to twenty per cent of Canada's total power requirement in 1968.

It is an impressive response to the steadily growing demand of Canadians for more electrical energy and a source of world-wide interest because of its magnitude.

The basic concept, corporate development, financing, management organization and the engineering and construction progress are presented in the following pages. The facilities described — Storage, Power Installations, Transmission Lines and Support Facilities — comprise the major construction divisions of the Churchill Falls Development.

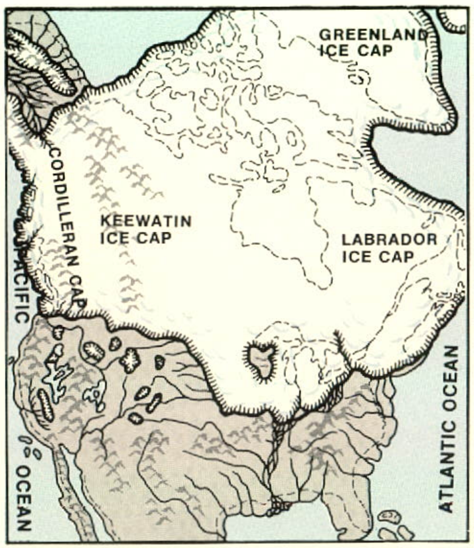
While the concept is straightforward and simple, nevertheless, its implementation has depended on many complex and advanced economic and technical considerations. To the thousands who now share in the execution of the Project, there is a compelling challenge to control quality, meet time schedules, stay within cost estimates, and produce and deliver, before long, Power From Labrador.

4 Upper Churchill Basin



Contents

History



Land forming

The granitic gneiss of Central Labrador's bedrock dates back three billion years to the Precambrian geological era. However, the plateau, as we now see it, was formed during the past ten million years when successive continental glacier advances carried with them, to the Atlantic coast and into what is now the United States, much of the surface of the Canadian Shield. At the same time, they gouged out large troughs in the Precambrian bedrock. There is evidence that the glacial till, sand and gravel now used for dyke building was rearranged several times during this period by ice and water erosion.

Exploration

When the ice finally melted (from Central Labrador, about 4500 BC), the resulting valleys and low areas became lakes and rivers — the canoe highways of the early explorers and traders. One of these ice-formed river valleys was the long, deep gorge of the Lower Churchill River. The first exploration of the river took place in 1839. A geological survey of the area was carried out in 1892. Economic development awaited the construction of the Quebec North Shore & Labrador Railway and the mining of the extensive iron deposits of Labrador in 1954.

Concept and planning

In 1953, the British Newfoundland Corporation Limited (Brinco) was formed to develop hydraulic and other resources in Newfoundland and Labrador. Early surveys resulted in the "channel concept" for the development of the Upper Churchill. In 1957, a 105-mile road was constructed from the railway to the Churchill River above the Falls. In 1962, power from the Twin Falls Development became available for Western Labrador's fast growing iron mining operations. In 1963, with advances in extra-high voltage transmission and a growing demand for power, final studies for the Churchill Falls Development were begun.

Construction

In 1964, H. G. Acres & Company Limited and Canadian Bechtel Limited formed a joint venture called Acres Canadian Bechtel of Churchill Falls (ACB) to provide engineering and construction management services to Churchill Falls (Labrador) Corporation Limited (CFLCo). In 1966, a letter of intent was signed with Hydro-Quebec for the purchase of most of the energy available from the site. It permitted work to start on construction. By the end of 1969, most of the underground power complex had been excavated and substantial progress had been made on all other parts of the power development.

Upper Churchill Plateau

- 1,300 to 1,900 feet above sea level
- Hills rise approximately 500 feet above plateau level.
- Water level in Lower Churchill gorge at power site: 420 feet above mean sea level.

Precipitation

Average annual: 30.1 inches.

Temperatures

Range from −55°F to 87°F.
−48°C to 30°C.

Average annual: 25°F.
−4°C.

Vegetation

Shallow muskeg and irregular low spruce forest growth.

Bedrock Geology

Metamorphic granitic gneiss intruded by gabbro-diorite and syenite and cut by stable faults parallelling and intersecting the Lower River.

Surface Geology

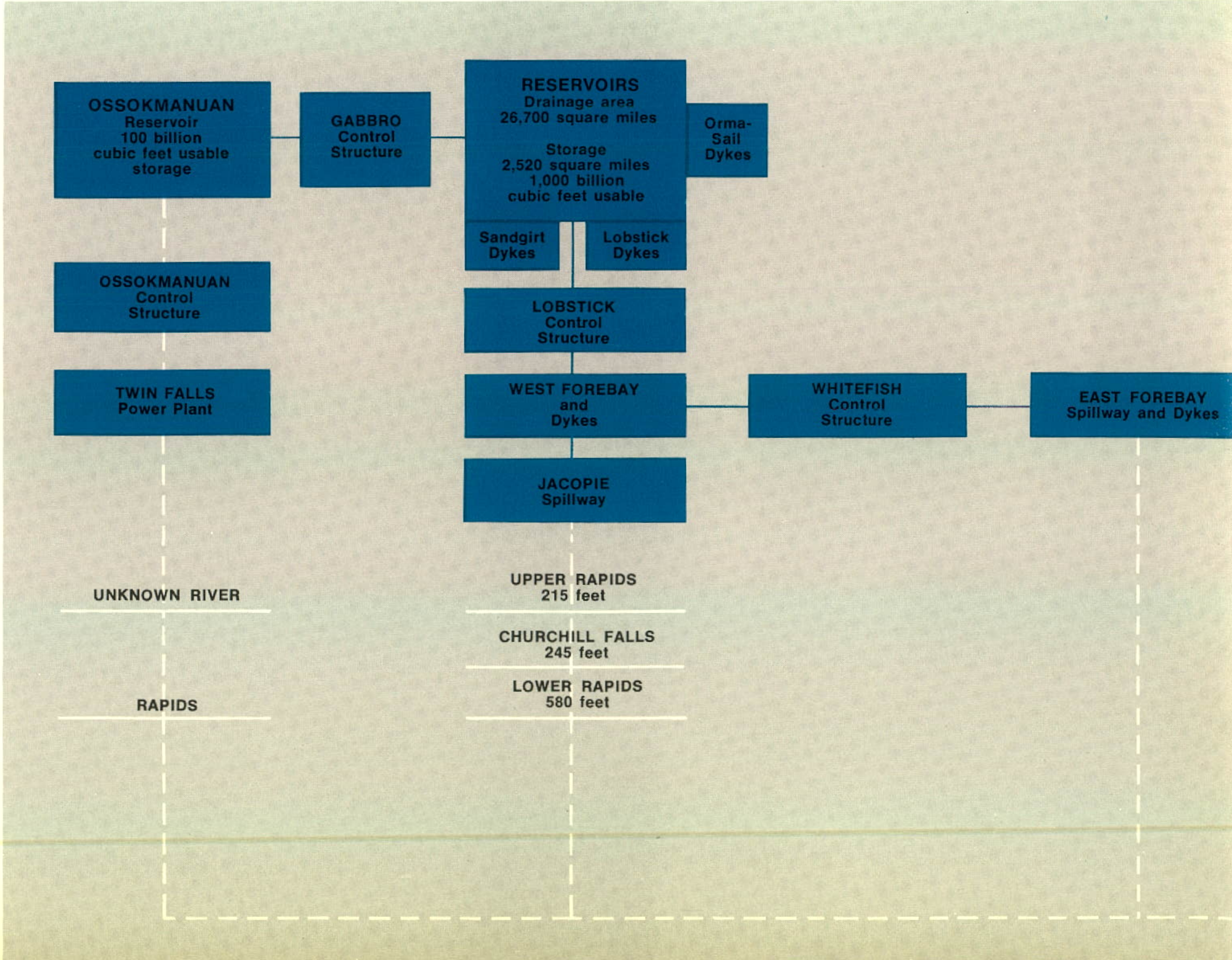
Irregular glacial deposits of silty sand, gravel and boulders in random thicknesses up to 40 feet in the area of the power site.

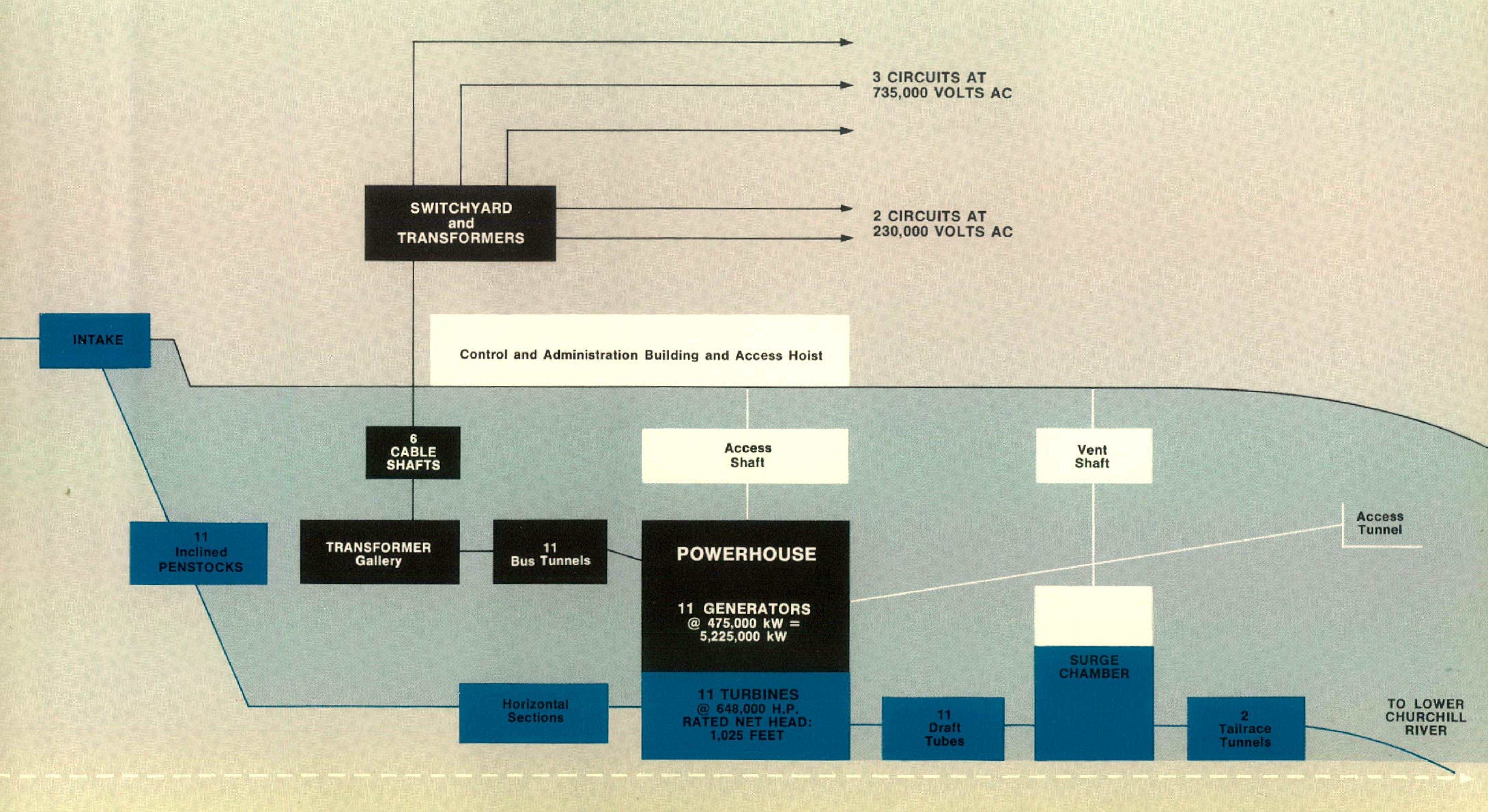
Development of the concept

In the "channel scheme", the waters of the Upper Churchill River Basin are enclosed by dykes and augmented by low diversion dams on the plateau. The controlled river flow is directed from its natural course above the Churchill Falls in a new channel on the plateau to the Forebay Intake, 16 miles east of the Falls. Here, a dependable flow of 49,000 cubic feet per second with a net head of 1,025 feet is obtainable above an underground power complex located only one mile north of the Lower Churchill. The reservoir for the power plant at Twin Falls already forms a part of the Churchill Falls Power Development.

In locating the limits of the reservoir and the dykes, channels, forebay and control structures, extensive photogrammetry and photo interpretation studies were required.

To provide reliable extrapolation of the limited actual river flow data, transposition of records from other regional rivers was carried out.




3 CIRCUITS AT
735,000 VOLTS AC
SWITCHYARD and TRANSFORMERS
2 CIRCUITS AT
230,000 VOLTS AC
INTAKE
Control and Administration Building and Access Hoist
6 CABLE SHAFTS
Access Shaft
Vent Shaft
Access Tunnel
11 Inclined PENSTOCKS
TRANSFORMER Gallery
11 Bus Tunnels
POWERHOUSE
11 GENERATORS
@ 475,000 kW =
5,225,000 kW
SURGE CHAMBER
Horizontal Sections
11 TURBINES
@ 648,000 H.P.
RATED NET HEAD:
1,025 FEET
11 Draft Tubes
2 Tailrace Tunnels
TO LOWER CHURCHILL RIVER

Corporate development

The Government of Newfoundland recognized early that one of the most challenging aspects of power development at Churchill Falls arose from its magnitude. Thus, strong financial and corporate management was essential. Having been associated with Great Britain before Confederation with Canada in 1949, Newfoundland welcomed the interest of seven United Kingdom banking and industrial firms. These formed, in 1953, British Newfoundland Corporation Limited to develop the power and other resources of Newfoundland and Labrador.

Brinco was granted exclusive mineral rights for a 20-year period over more than 50,000 square miles in both Newfoundland and Labrador. It also obtained rights to develop river systems in both areas.

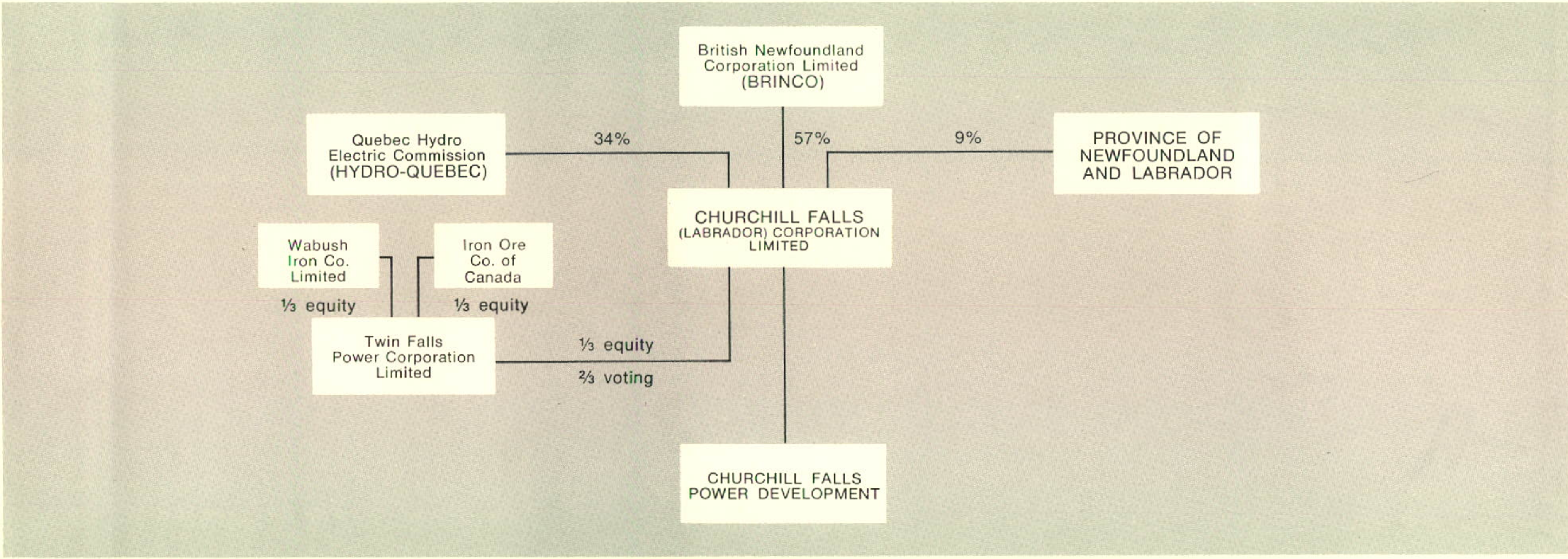
To carry out its commitment at Churchill Falls, Brinco formed Churchill Falls (Labrador) Corporation Limited and then strengthened and broadened this corporate organization. In doing this, the provincial jurisdiction over the resource has been allied with private shareholders, experienced resource development corporations, large sources of capital and the principal purchaser of its power, Hydro-Quebec.

Financing Cost estimates established the capital required to complete the development at $946 million dollars. To meet this requirement the largest financing ever undertaken for a single industrial enterprise was negotiated, as shown in the following rounded figures:

Funds required	**in millions**
Storage and Forebay	$ 115
Power Plant and Generators	168
Switchyard and Transmission	100
Permanent Support Facilities	25
Temporary Facilities and Services	83
Management and Engineering	31
	$ 522
Escalation	102
Contingency	41
Direct Construction Costs	$ 665
Interest during Construction	189
Administration, Overhead and Miscellaneous	92
TOTAL	$ 946

Funds made available	**in millions**
Equity paid	$ 83
Mortgage Bonds	
Series A (U.S. $500 million)	540
Series B	50
General	100
Retained Earnings during Construction	150
	$ 923
Bank Financing available	150
TOTAL	$1,073

Signing of bank financing agreement.


British Newfoundland Corporation Limited (BRINCO)
Quebec Hydro Electric Commission (HYDRO-QUEBEC)
34%
57%
9%
PROVINCE OF NEWFOUNDLAND AND LABRADOR
CHURCHILL FALLS (LABRADOR) CORPORATION LIMITED
Wabush Iron Co. Limited
Iron Ore Co. of Canada
⅓ equity
⅓ equity
Twin Falls Power Corporation Limited
⅓ equity
⅔ voting
CHURCHILL FALLS POWER DEVELOPMENT

12 Management control

Acres Canadian Bechtel of Churchill Falls is the distinct engineering and construction management unit for the project.

Plans are prepared by ACB and other design firms for CFLCo review and approval. Execution of plans is carried out under ACB management.

CFLCo management divisions have responsibility for the quality, cost and schedule of work conducted by ACB. Control channels in this regard are internal to the CFLCo organization through the Project Manager.

In both CFLCo and ACB, project management is divided essentially into Engineering and Construction groups. The latter groups are subdivided into Storage, Power Complex, Transmission and Support Facilities.

Divisional managers in each organization communicate constantly and regularly. Some assignments are undertaken by ACB and CFLCo jointly using special task forces set up to deal with particular problems. For example, the geotechnical problems related to the excavation of the power complex were reviewed regularly by a joint Geotechnical Task Group. This permitted prompt recommendations to management to meet the changing conditions exposed by actual excavation.

Planning and scheduling The Master Project Schedule was developed using the Critical Path Method (CPM) and bearing in mind the requirements of the principal customer, Hydro-Quebec. In optimizing the time-cost relationship, several schedule arrangements and activation sequences were considered.

From an original plan with a low level of detail, involving 750 activities, schedule networks were developed to include nearly 3,000 activities. Discrete contract elements were then defined with consideration for the financial and other (e.g. seasonal) capabilities of the heavy construction industry.

Actual progress is constantly monitored and compared with the Master Project Schedule. Data obtained from the site, design offices and widespread manufacturing plants are computer-processed with careful note made of the trends of "float" periods in each schedule. Contractors are required to submit, for the Manager's approval, their own schedules for meeting the Master Schedule dates.

Cost controls The Churchill Falls Power Development involves 78 contract packages. To afford management the opportunity to vary design before commitment to a certain course of development, the first stage of cost control begins with the study of alternatives, through detailed engineering to calls for tenders.

The second stage starts at contract award. This involves continuous surveillance and forecasts of quantities and costs. Cost revisions involving changes in contract quantity estimates are regularly communicated to management. Capital appropriations are required for all work performed and all major purchases. A monthly budget cost and forecast sheet is prepared, detailing by tender items original estimated quantities, the cost to date, and forecast total costs.

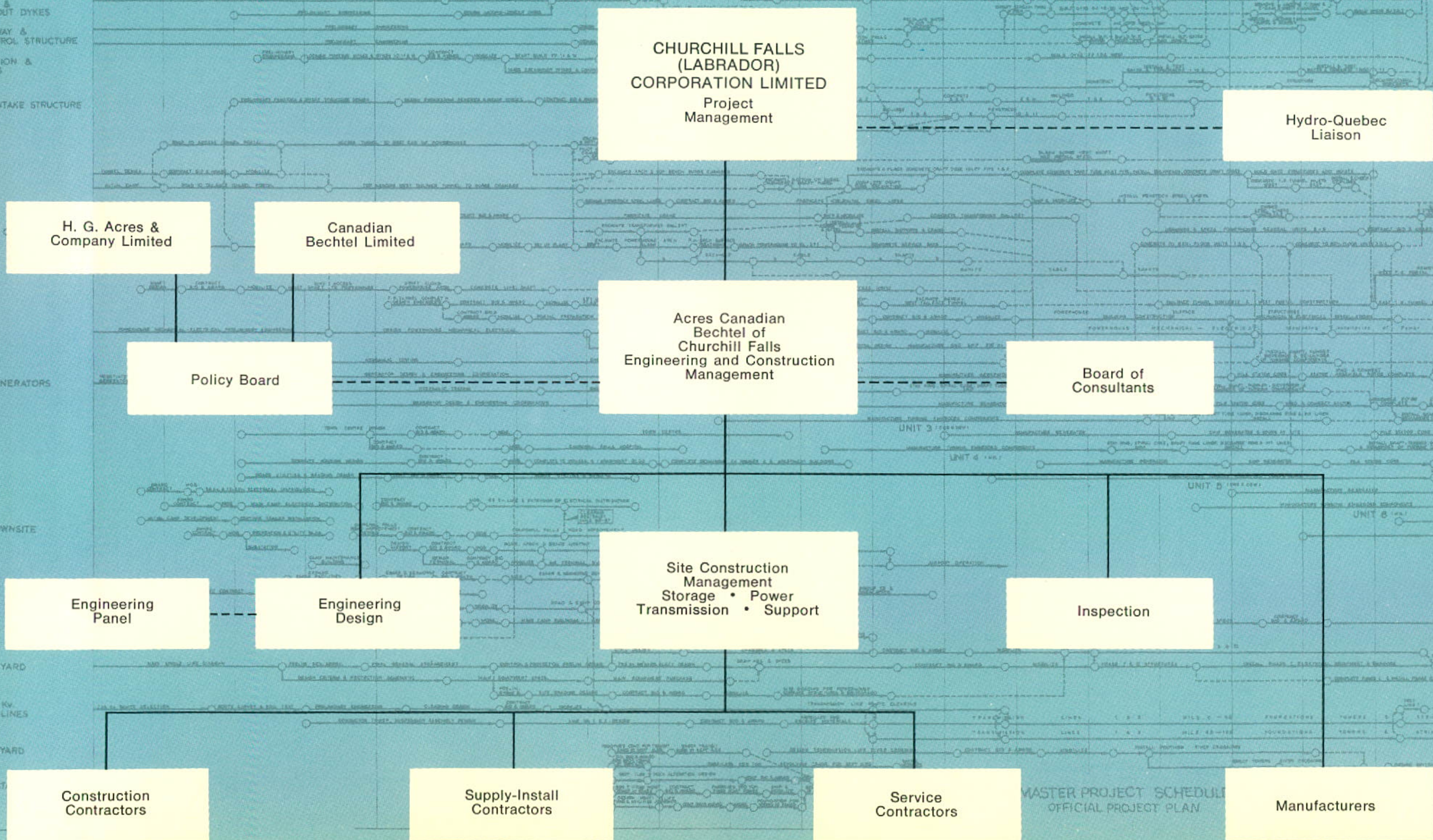
Quality control Quality standards are set out in each contract document and purchase order. The Quality Control Group's function is to see that the actual work performed and material delivered conform precisely to the specified standards. Different levels of control include:

- Adequate quality control systems provided by each contractor.
- Independent inspection firms engaged to visit suppliers' manufacturing plants or to conduct site laboratory tests on critical materials such as concrete and soils.
- A staff of qualified inspectors employed by ACB.
- CFLCo's professional representatives assigned to monitor and inspect work as it progresses.

Safety First responsibility for accident prevention at the Churchill Falls site rests with each employer. Minimum safety requirements are outlined in the Manager's Accident Control Program.

The Workmen's Compensation Board of the Province of Newfoundland and Labrador provides inspectors to ensure conformity with provincial Accident Prevention Regulations. Because of the 300 miles of project roads, traffic safety is of particular importance. Trained underground rescue teams and a surface fire department provide fire protection to personnel and property.

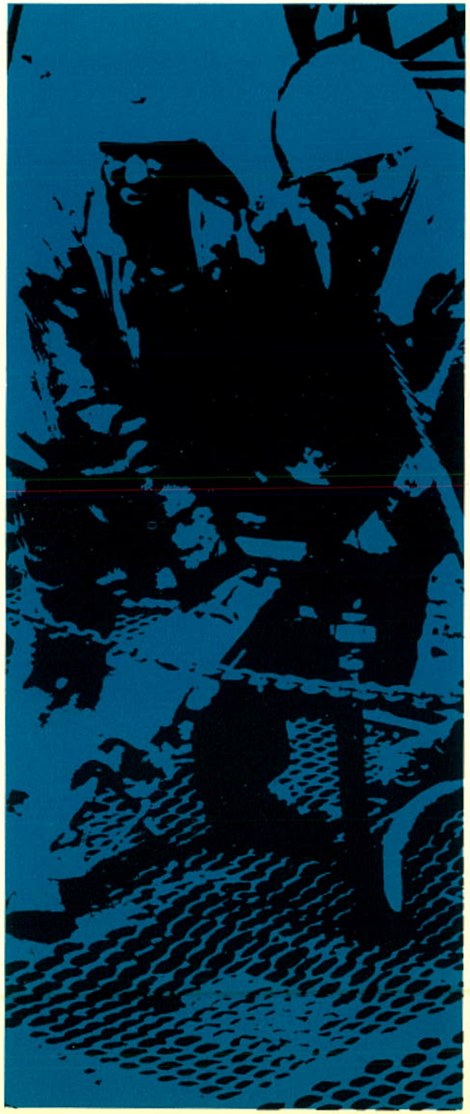
Project organization



14 Contractors and the work force

CONTRACTORS

When the development is completed, 78 major contracts will have been executed and agreements with 46 concessionnaires and licensees will have been carried out. The contractual agreements with each individual contractor and concessionnaire follows a standard form specifying safety standards, work quality, completion dates, quantity and lump sum prices, relationship with government agencies, etc. One of the most important features of the contract is the obligation of the contractor to co-operate with the Manager in monitoring work progress and to advise the Manager of any events which could affect the completion of his contract in accordance with the Master Project Schedule. Contractors are represented by The Churchill Falls Power Project Contractors' Association.



THE WORK FORCE

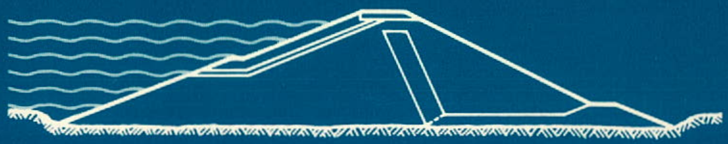
Employment With site employment alone exceeding 6,000 (during 1970, the peak year), the Churchill Falls Development will require, over the full construction period, to 1975, a total of approximately 52 million man-hours of work, embracing almost 200 categories of employment. As mentioned above this does not include off-site employment which for turbine and generator fabrication alone will require the equivalent of 600 employees working for a six-year period.

Labor Relations Representation of employees on the project is provided through The Churchill Falls Power Project Council. This council consists of twelve Building Trades (A.F. of L. — C.I.O. — CLC) Unions which have signed an eight-year collective agreement with The Churchill Falls Power Project Contractors' Association.

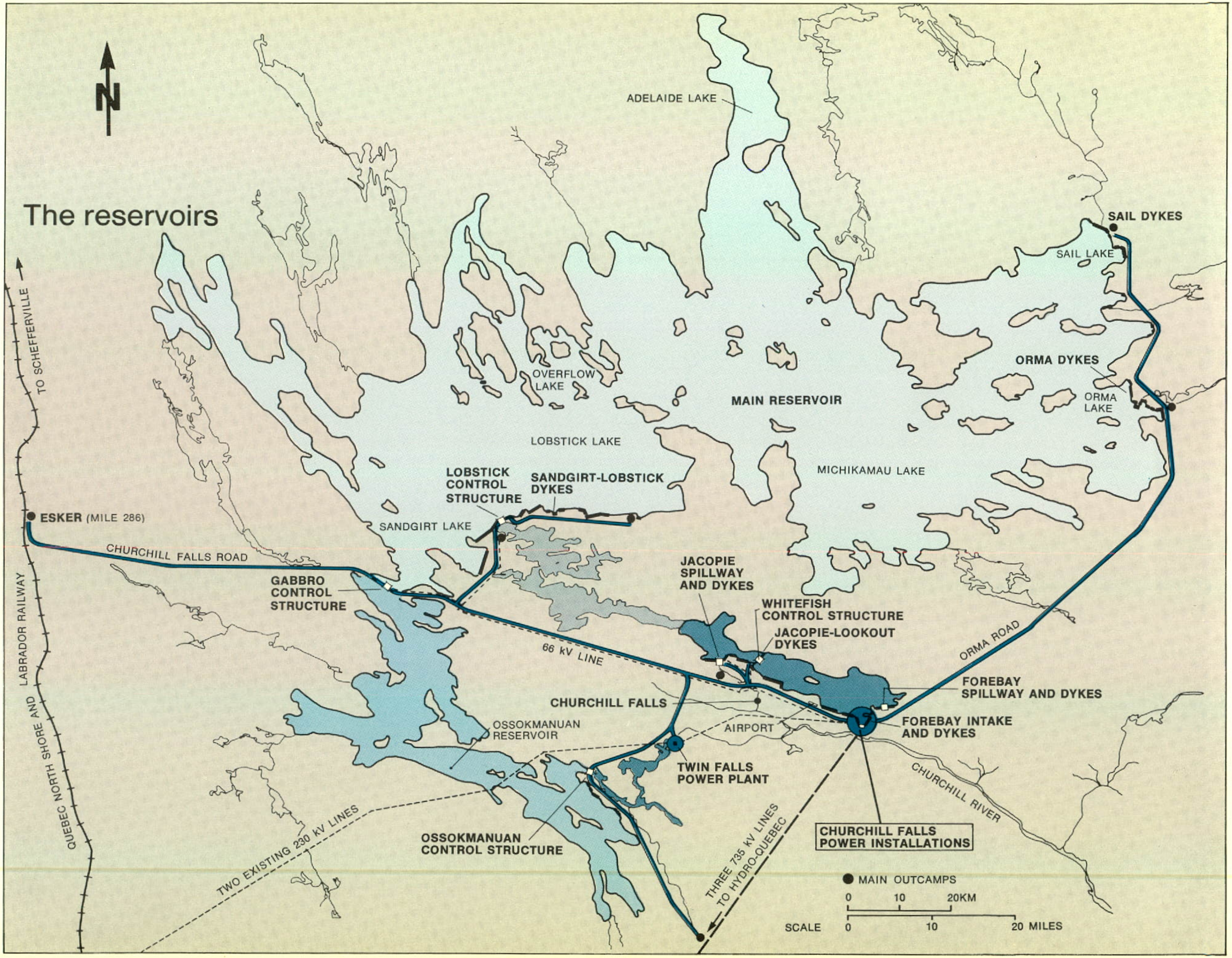
This agreement outlines employees' and contractors' rights and provides a formula for guaranteed wage increases every six months, as well as establishing a procedure for the hearing of grievances.

Because of the large numbers of skilled workers required, it has been necessary in several cases to train or upgrade personnel for the project. To facilitate training, manpower forecasts have been drawn up and, where necessary, the provincial and federal governments have co-operated in sponsoring training programs through vocational training institutes in the province.

The storage facility 15



The reservoirs



THE RESERVOIRS

The Main and Ossokmanuan Storage Reservoirs, covering together 2,520 square miles, are enclosed by 40 miles of low level dykes and six control and spillway structures. They will collect the drainage from the 26,700 miles of modified and controlled Upper Churchill River Basin. The 1,100 billion cubic feet of usable storage thus created will be replenished by an average of 30.1 inches of annual precipitation over the basin. The reservoirs will provide a regulated flow of 49,000 cubic feet per second.

DYKES

There are three basic dyke designs. All have coarse rock or rip-rap protection against wave action.

Homogeneous dykes are the most common and are made of compacted glacial till. When this type of dyke exceeds 40 feet in height a gravel chimney drain is included.

Rockfill dykes are used when broken rock is available from nearby excavations to stabilize an impervious core. They include two processed gravel transition zones.

Composite dykes are similar to rock shell dykes with gravel replacing the rock shells.

Total volume of dyke material	26,000,000 cu. yd.
Total number of dykes	90
Average height	30 feet
Highest height	120 feet
Largest (Sail Lake area)	2,830,000 cu. yd. 19,725 ft. long

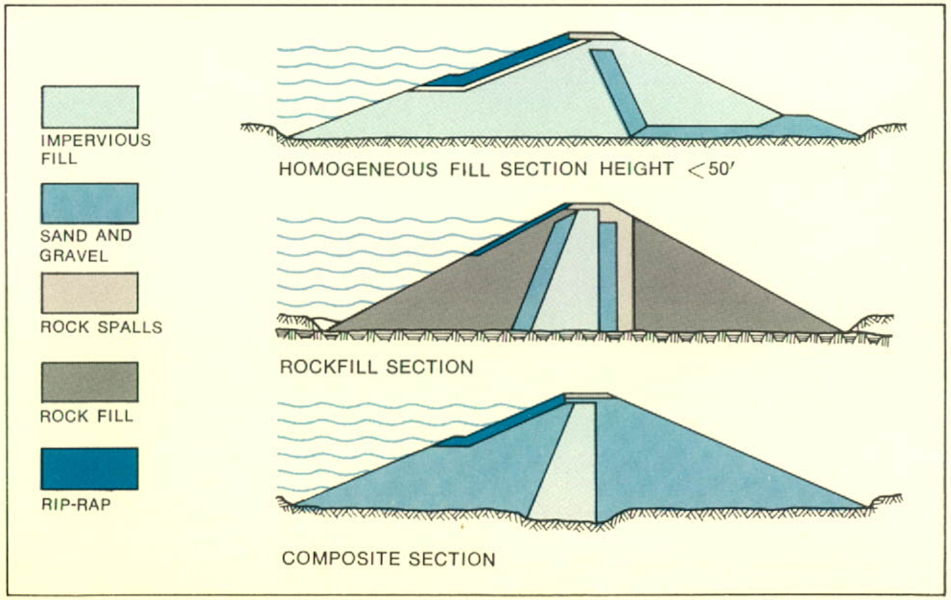
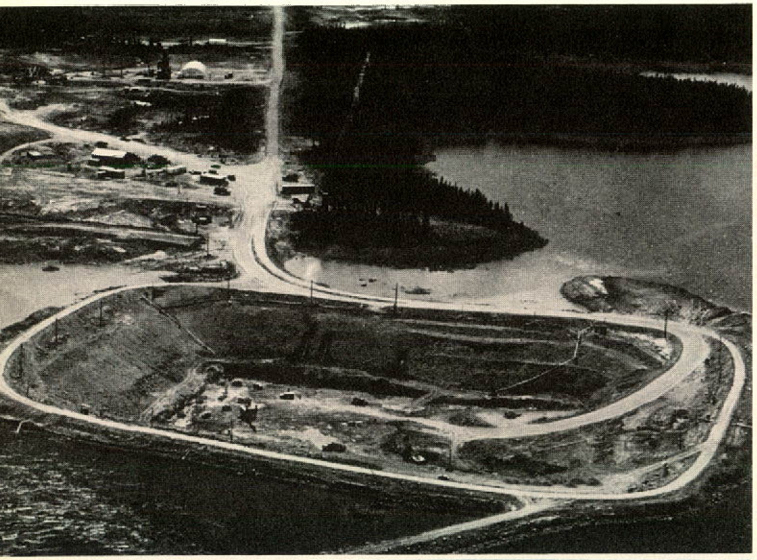


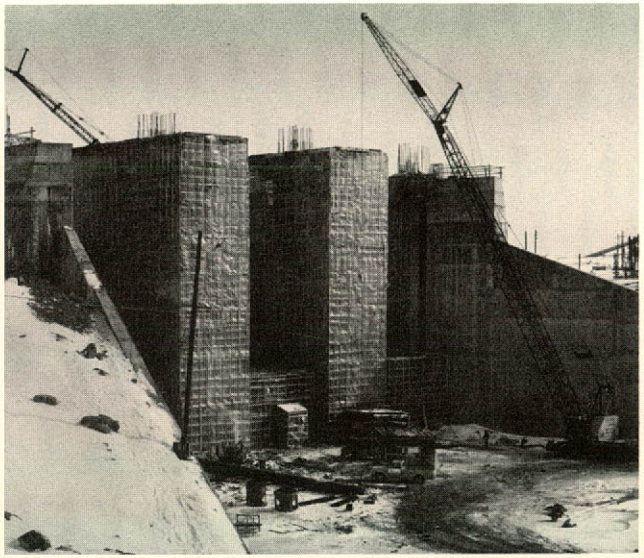
Photo shows rockfill dyke at Intake. Note core and transition zones.

18 Control structures and spillways

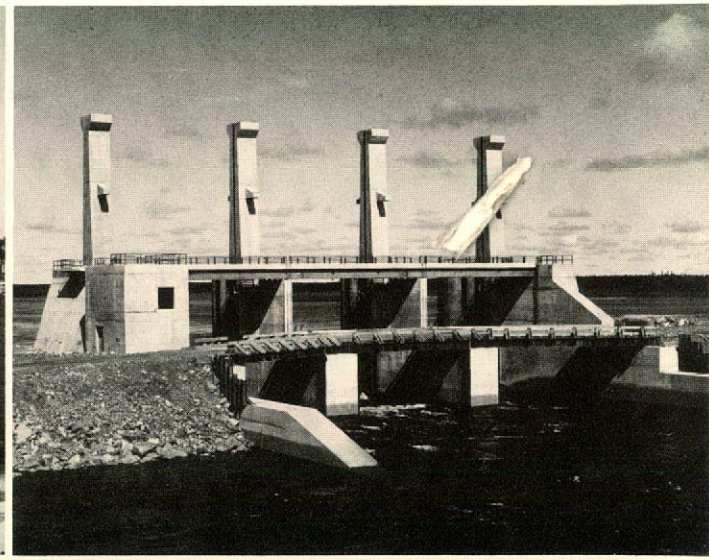
1

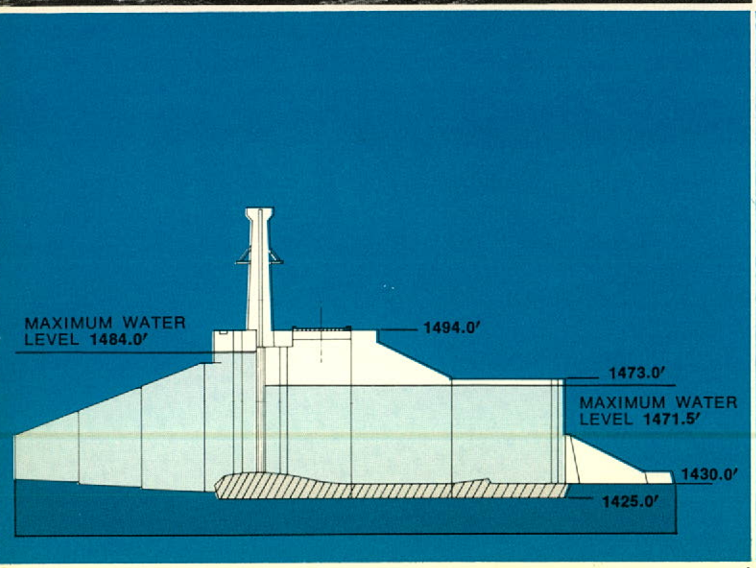


2

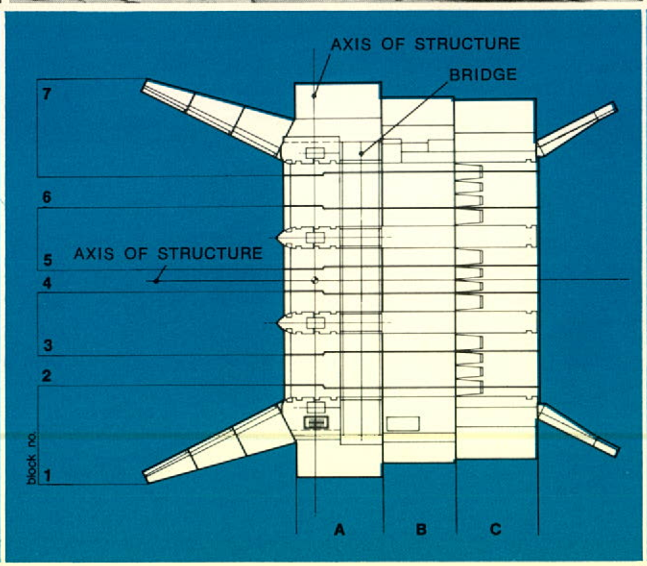


3

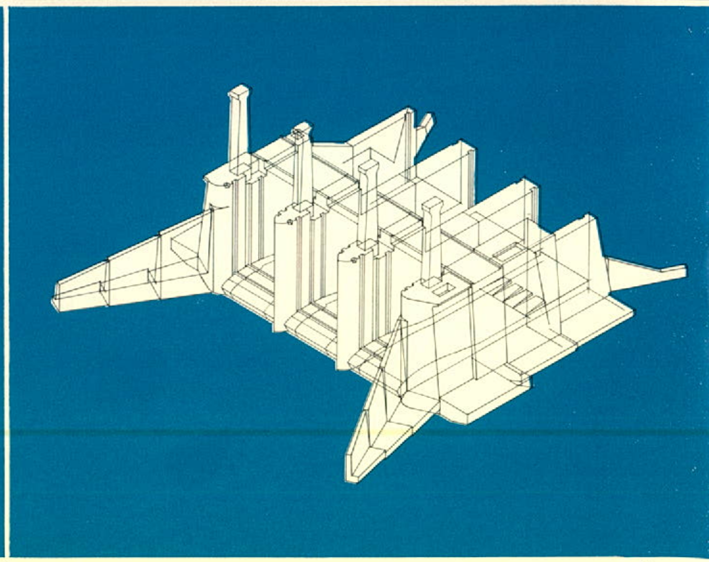




4



5

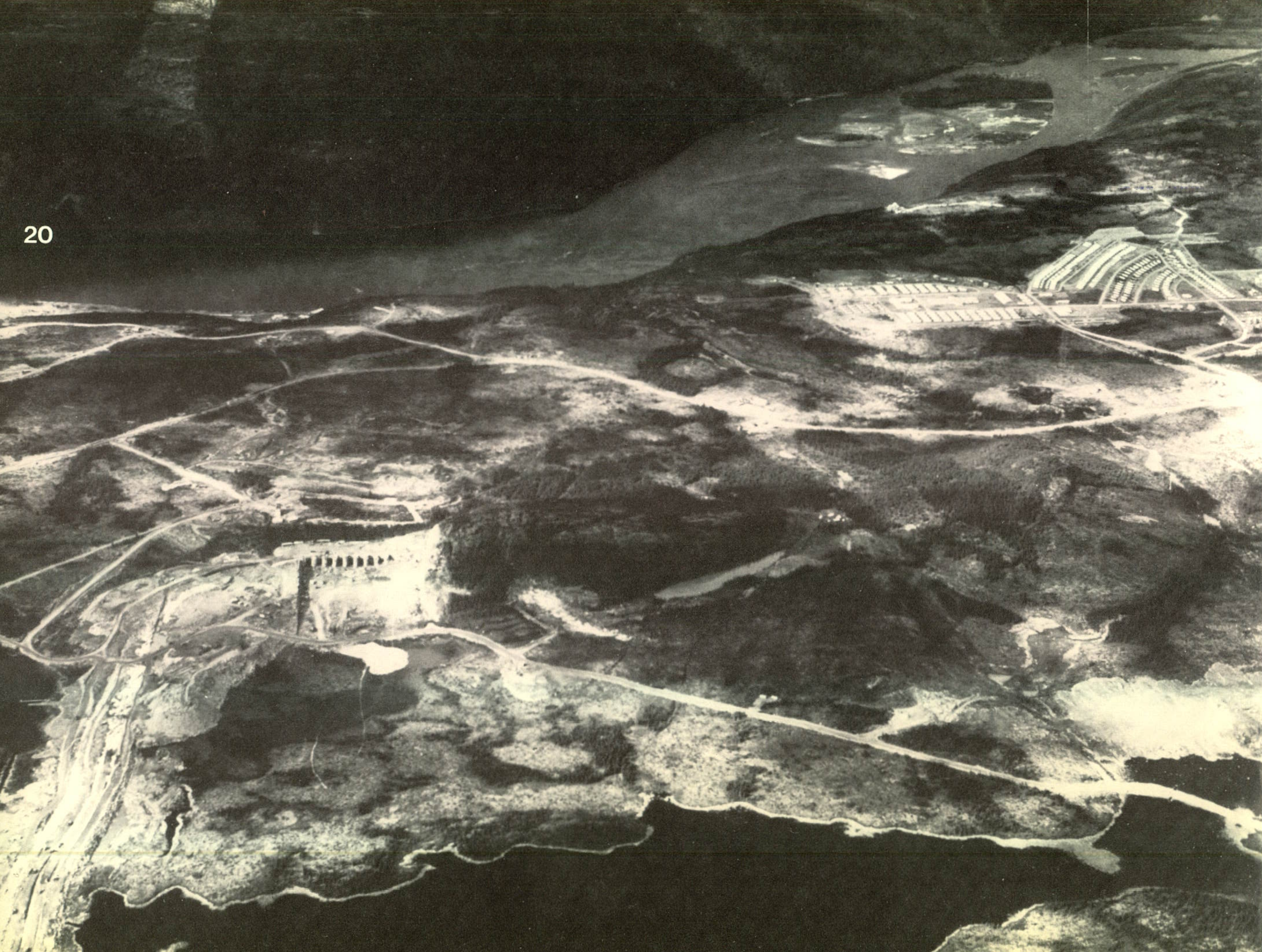


6

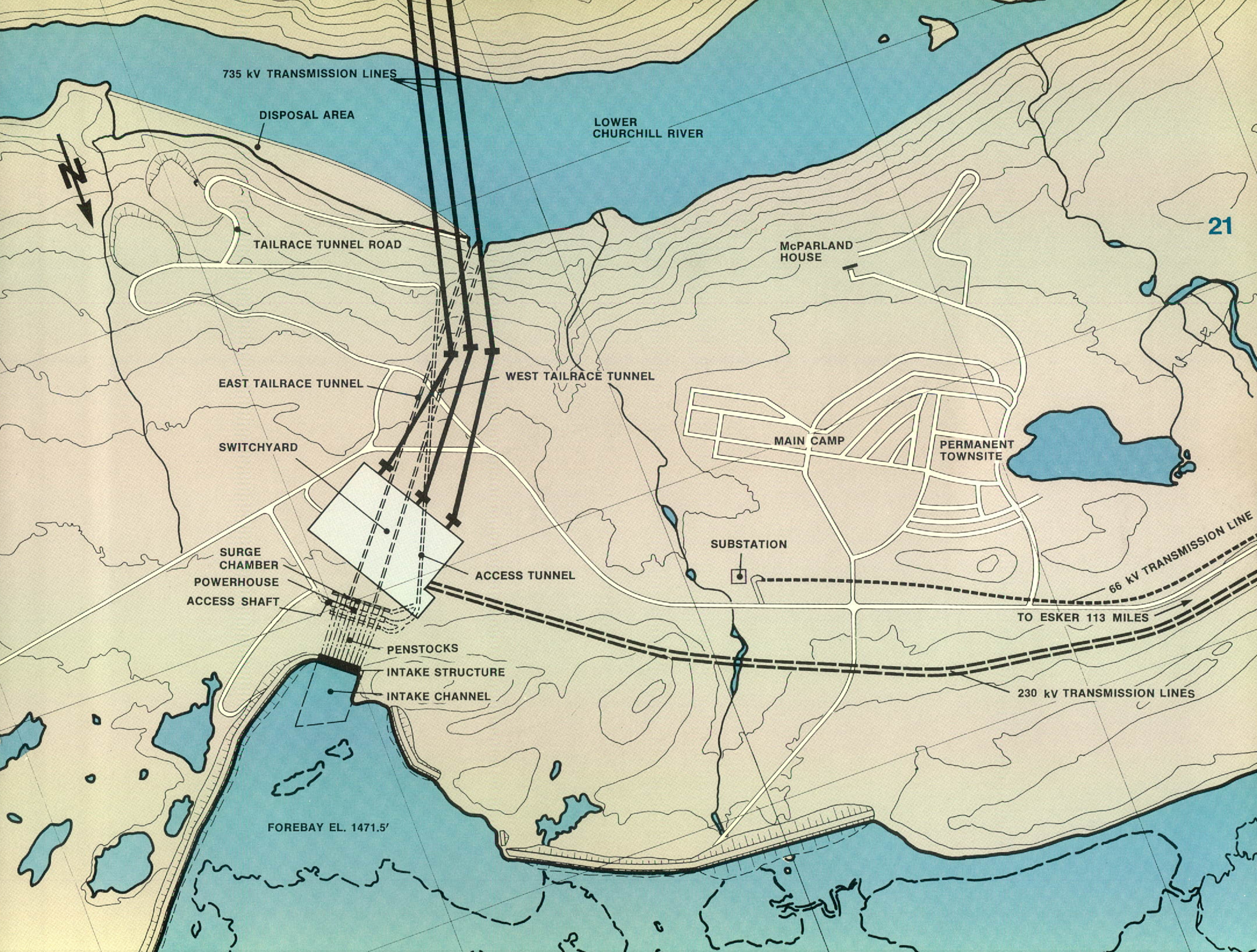
	Storage Volume in billion cubic feet	Concrete in cubic yards	Maximum Storage Elevation in feet*	Minimum Storage Elevation in feet*	Discharge Capacity in cubic feet per second
Ossokmanuan Reservoir	100				
Ossokmanuan Control Structure		16,950	1572	1558.5	115,000
Gabbro Control Structure		21,000	1572	1558.5	72,000
Main Reservoir	1,000				
Lobstick Control Structure		94,000	1551	1522.5	230,000
Channel and Forebay					
Jacopie Spillway		29,000	1486	—	165,000
Whitefish Control Structure		25,000	1484	—	100,000
Forebay Spillway		18,000	1471.5	1468.5	105,000

*Above mean sea level

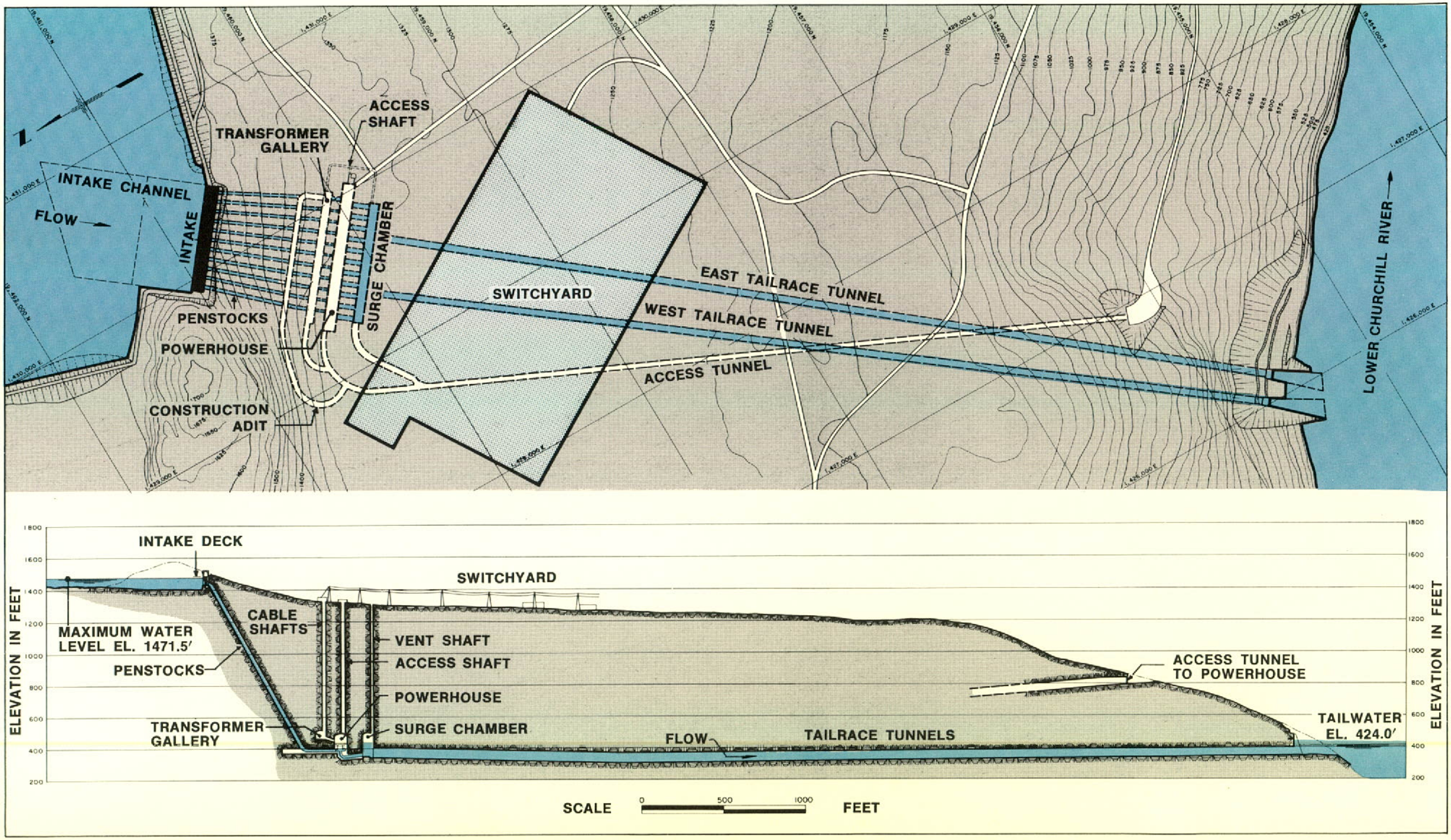
1. Lobstick Excavation
2. Lobstick Winter Construction Protection
3. Lobstick from Downstream
4. Whitefish North Wingwall
5. Whitefish Pouring Plan
6. Whitefish Isometric



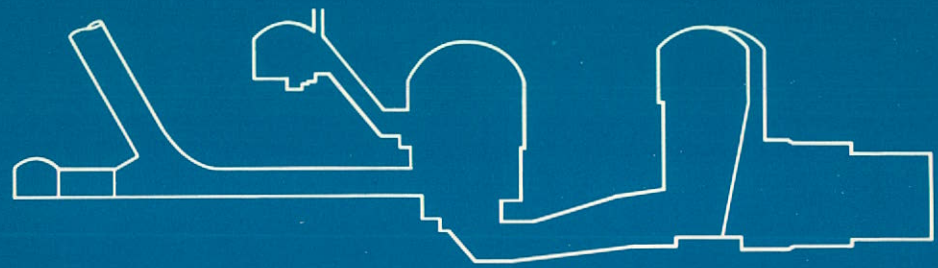
20

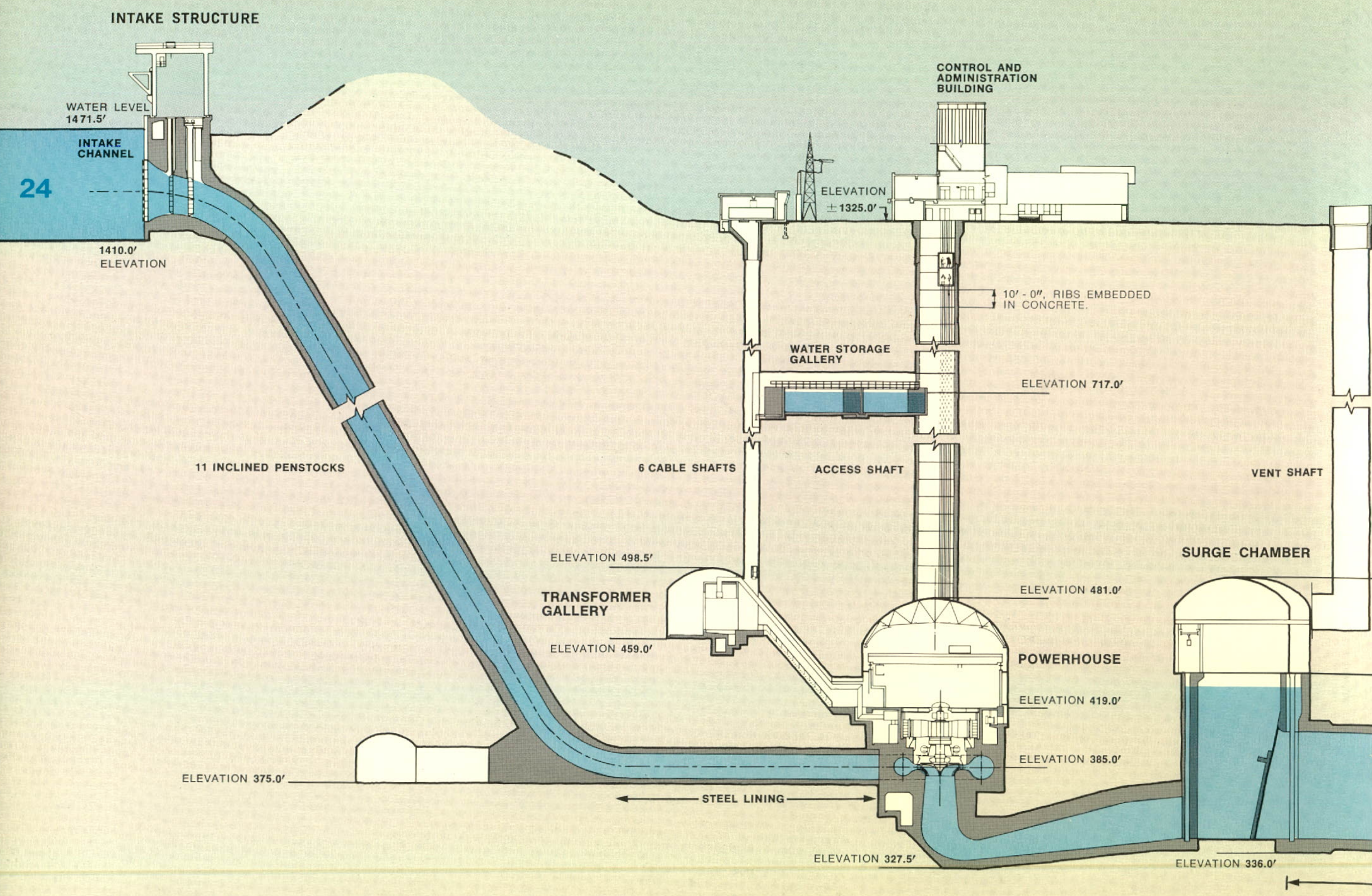

735 kV TRANSMISSION LINES
DISPOSAL AREA
LOWER CHURCHILL RIVER
N
TAILRACE TUNNEL ROAD
McPARLAND HOUSE
EAST TAILRACE TUNNEL
WEST TAILRACE TUNNEL
SWITCHYARD
MAIN CAMP
PERMANENT TOWNSITE
SUBSTATION
66 kV TRANSMISSION LINE
SURGE CHAMBER
POWERHOUSE
ACCESS SHAFT
ACCESS TUNNEL
TO ESKER 113 MILES
PENSTOCKS
INTAKE STRUCTURE
INTAKE CHANNEL
230 kV TRANSMISSION LINES
FOREBAY EL. 1471.5′

Underground general arrangement



The power facility 23

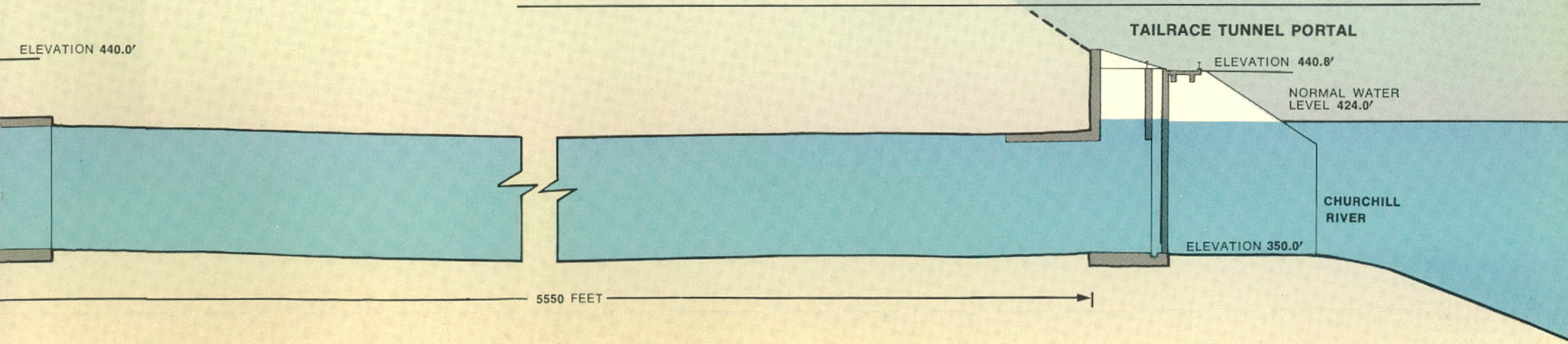


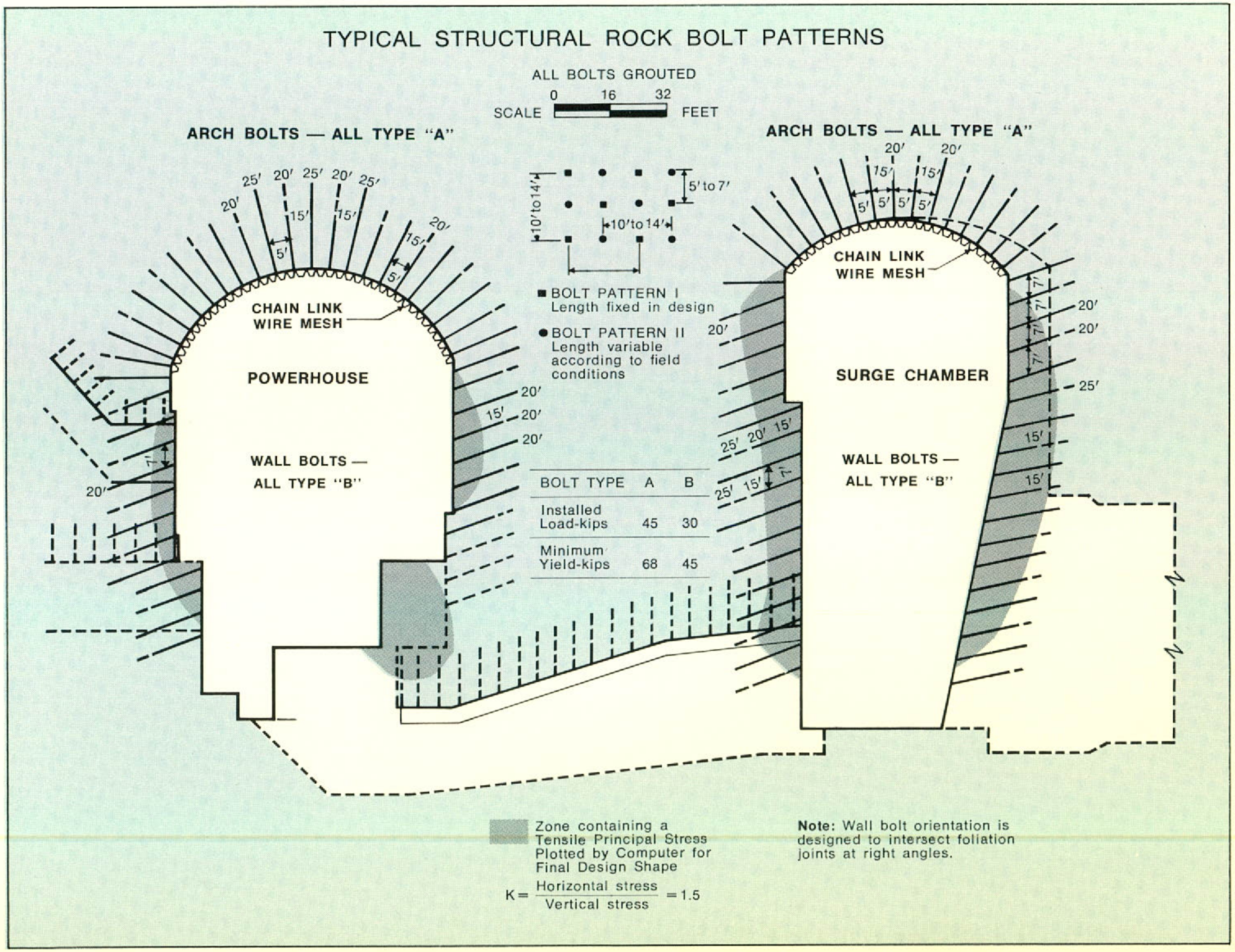

INTAKE STRUCTURE
WATER LEVEL 1471.5′
INTAKE CHANNEL
1410.0′ ELEVATION
CONTROL AND ADMINISTRATION BUILDING
ELEVATION ±1325.0′
10′ - 0″, RIBS EMBEDDED IN CONCRETE.
WATER STORAGE GALLERY
ELEVATION 717.0′
11 INCLINED PENSTOCKS
6 CABLE SHAFTS
ACCESS SHAFT
VENT SHAFT
SURGE CHAMBER
ELEVATION 498.5′
TRANSFORMER GALLERY
ELEVATION 459.0′
ELEVATION 481.0′
POWERHOUSE
ELEVATION 419.0′
ELEVATION 385.0′
ELEVATION 375.0′
STEEL LINING
ELEVATION 327.5′
ELEVATION 336.0′

POWER INSTALLATIONS

Gross Head	1,060 feet
Generating Units:	
Number	11
Rated Output	475,000 kW
Turbines:	
Rated Net Head	1,025 feet
Rated Output	648,000 hp
Rated Speed	200 rpm
Runaway Speed	330 rpm
Scroll Case Inlet Diameter	14 feet 7 inches
Runner Inlet Diameter	18 feet 10 inches
Runner Throat Diameter	14 feet 3 inches
Runner Weight	200,000 pounds
Total Weight (approx.)	2,700,000 pounds
Generators:	
Rated Capacity	500,000 kVA
Rated Voltage	15 kV
Power Factor (overexcited)	0.95
Synchronous Reactance	100 per cent (max)
Transient Reactance (unsaturated)	33 per cent (max)
Inertia Constant (H factor)	3.5 (min)
Rotor Diameter	29 feet 6 inches
Rotor Weight (each)	1,310,000 pounds
Stator Core Depth	9 feet 8 inches
Total Weight (approx.)	2,400,000 pounds

Penstocks:	
Number	11
Length (excluding intake transition)	1,400 feet
Internal Diameter — Concrete Lined	20 feet
— Steel Lined	14 feet 7 inches
Powerhouse	
Maximum Length	972 feet
Maximum Width	81 feet
Maximum Height	154 feet
Surge Chamber:	
Length	763 feet
Width (varies)	40 to 64 feet
Height	148 feet
Vent Shaft:	
Diameter	20 feet
Depth	829 feet
Tailrace Tunnels (Unlined):	
Number	2
Width	45 feet
Height	60 feet
Average Length (each)	5,550 feet
Transformer Gallery:	
Length	856 feet
Width	50 feet
Height	39 feet
Cable Shafts:	
Number	6
Internal Diameter	7 feet
Average Depth	865 feet





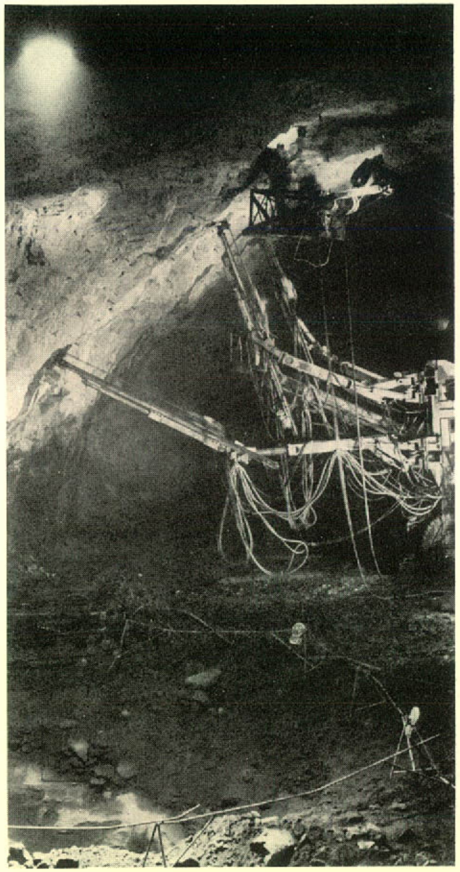
Investigation, Design and Construction

Bearing in mind cavity requirements for construction and operation, the location, shape, structural reinforcement, rock surface treatment and seepage control methods were developed using the following procedures:

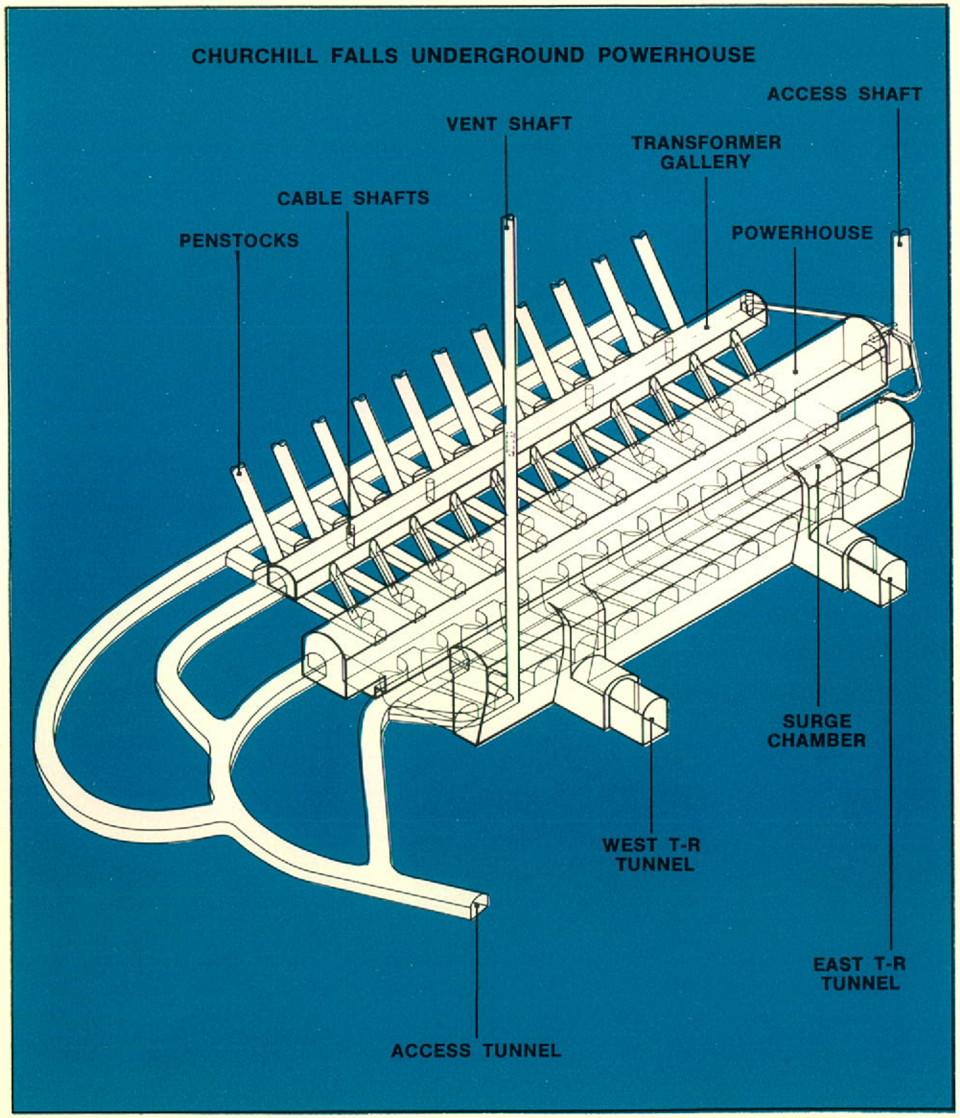
- Detailed geological mapping, air photo interpretation, test pitting, diamond drilling (approximately 40,000 feet of borehole), logging of all cores and laboratory testing of rock specimens were carried out along with hydraulic pressure testing and borehole photography in selected holes.
- Plate jack testing and overcoring techniques were used to determine the major, in situ rock characteristics and stress conditions.
- Finite element analyses of various cavity shapes were studied to optimize the location and minimize the extent of undesirable tensile stress zones and select the final arrangement of cavities.
- Rock bolt reinforcement patterns were designed in accordance with the above data. Bolt anchorages were located in favorable compression zones with optimum orientation to joints and foliation. Bolt strength and bolt spacing were determined from a study of possible rock separation conditions. All structural rock bolts were specified to be fully grouted.
- Where inter-bolt minor rock support is required it consists of flexible

wire mesh fastened to the rock surface by bolting. Inter-bolt rock ravelling conditions have been treated by guniting.

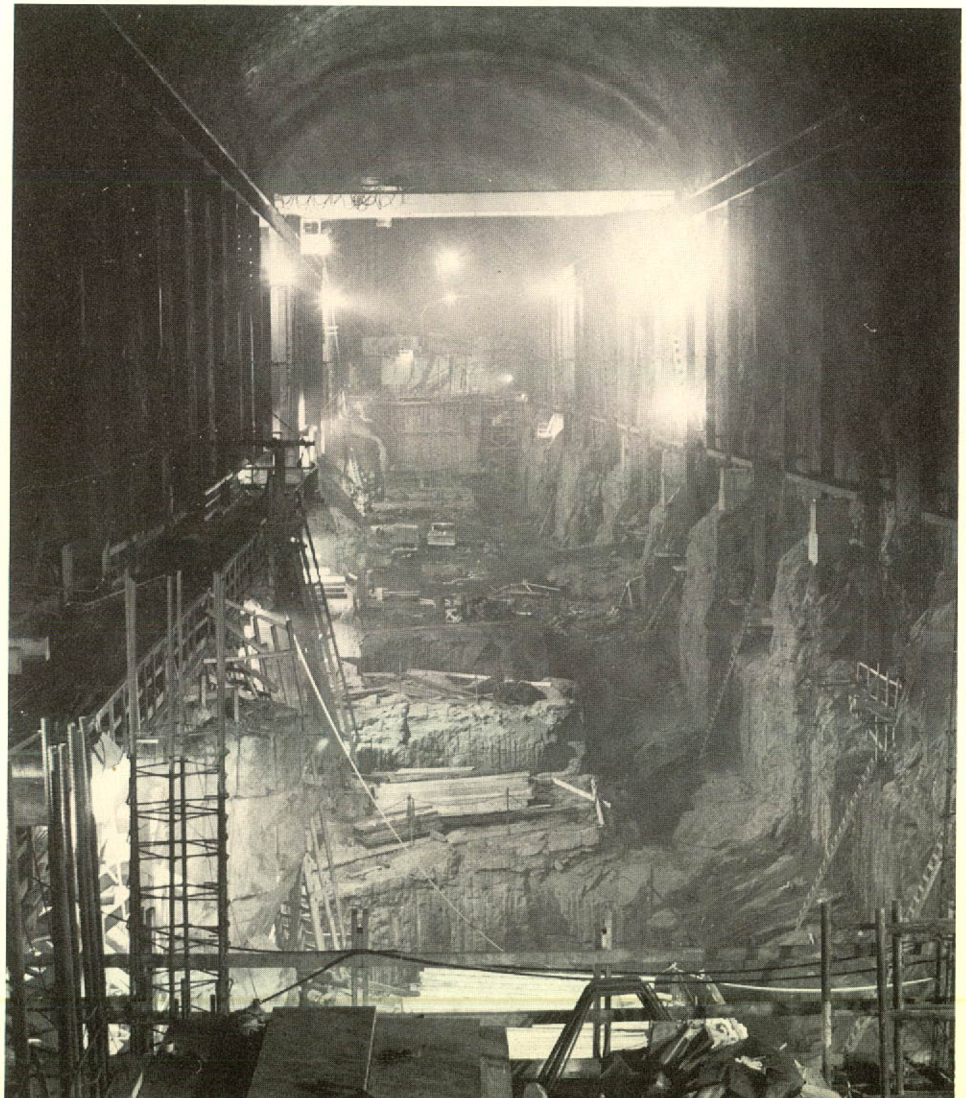
- Protection against falling rock chips, and possible seepage is controlled in the powerhouse with a stainless steel ceiling suspended from the rock arch by a special bolting arrangement.
- Anticipated exceptional stress conditions, for example in certain draft tube pillars, were controlled using high-strength solid steel tendons.
- Excessive damage to wall surfaces from blasting in all underground openings was minimized by using pre-shearing, cushion blasting or line drilling techniques.
- Water seepage and the build-up of undesirable water pressures in rock joints are controlled by extensive and carefully located patterns of pressure relief holes.
- A continuous program of underground geological surveys and rock monitoring instrumentation has been carried out during construction, using several types of borehole extensometers, rock bolt load cells and stress meters. This program has uncovered potential problem areas as well as areas where rock conditions were better than expected. As a result, rock bolt patterns and lengths were modified during construction to ensure maximum structural stability at minimum cost.



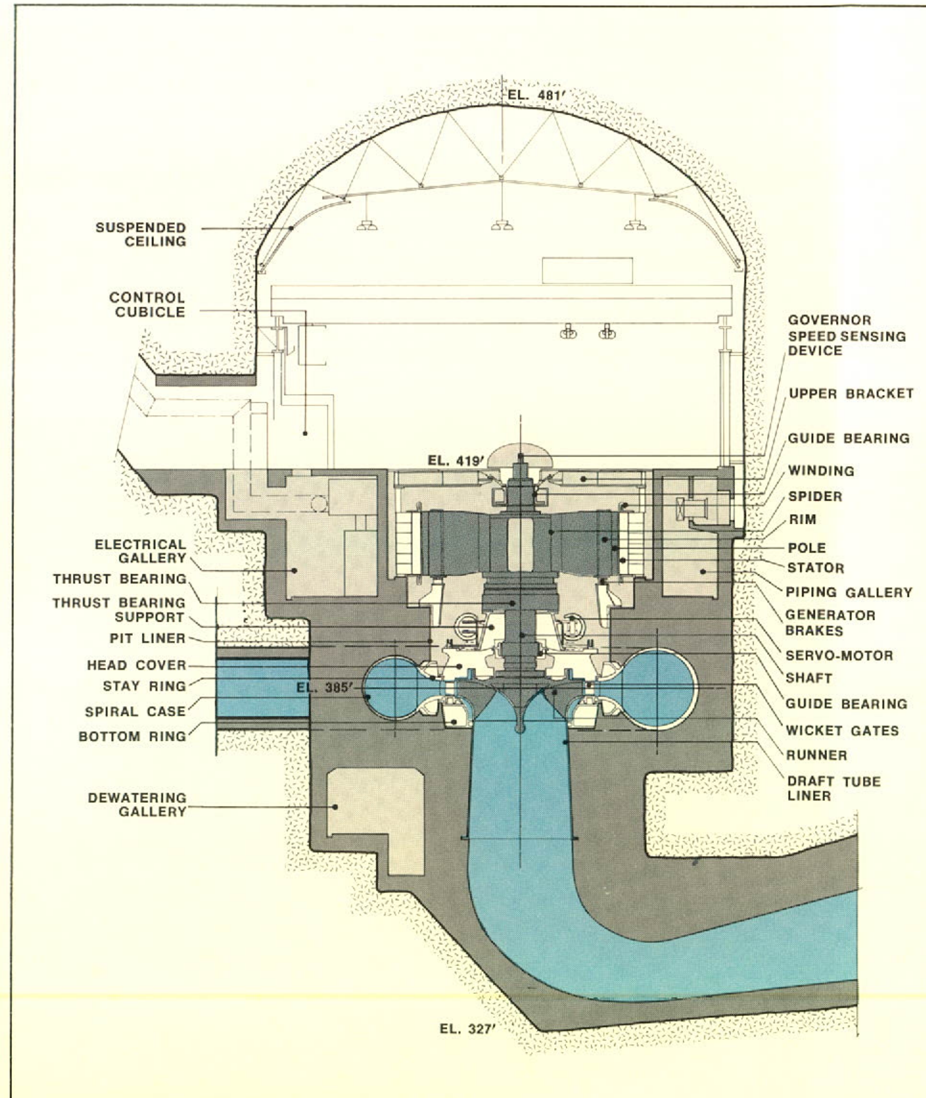
- The rock condition in the penstock area, was carefully investigated during excavation. As a result informed decisions were made with regard to costly steel liner installations in the elbow and inclined sections of the penstocks.



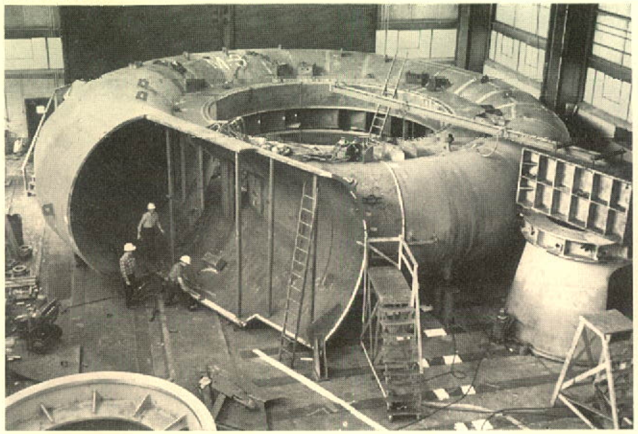
Powerhouse Excavation



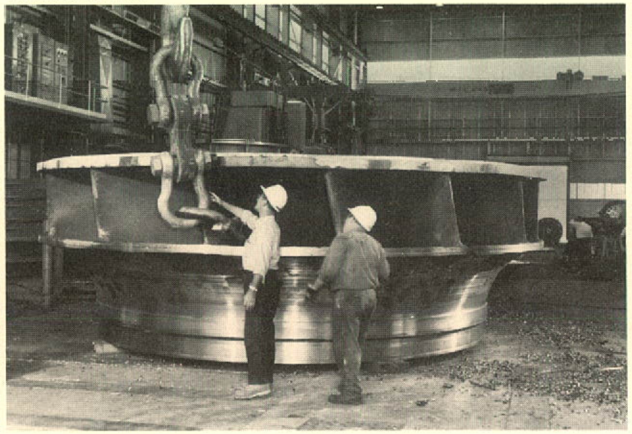
Turbine and Generator



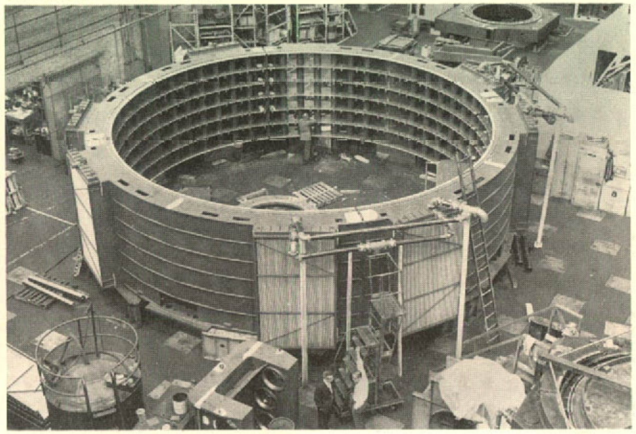
Scroll Case



Turbine Runner



Generator Stator Frame



The single-line diagram on Page 30 displays the arrangement of the unit system for the generator transformer connections and the 230 and 735 kV switchyards.

The generators are each rated at 500 MVA, 15,000 volts, 3-phase, 60 cycles per second, 0.95 power factor and 200 revolutions per minute and driven by hydraulic turbines rated at 648,000 horsepower at a net head of 1,025 feet. Each generator has two transformers solidly connected to its terminals one of which supplies the static excitation system and the other supplies the essential unit services.

The power is transmitted from the generators to the underground unit transformers through a forced air cooled isolated phase bus rated at 15,000 volts, 22,500 amperes. The unit transformers are rated at 500 MVA, 60 cycles per second, 3-phase, 14,750 - 240,000 volts.

Power is brought to the surface from the transformer gallery through vertical cable shafts, each approximately 900 feet in length and containing two three-phase circuits. The circuits consist of three 245,000-volt oil-filled cables which are terminated at the surface in potheads.

The 230 kV switchyard provides the required circuitry for connecting two units to a 230 kV - 735 kV auto-transformer. Connection to the existing Twin Falls system, which supplies Wabush and Labrador City, is also effected from this switchyard.

The main auto-transformer banks consist of three single-phase transformers each rated at 333 MVA, 715,000 - 236,000 - 13,800 volts.

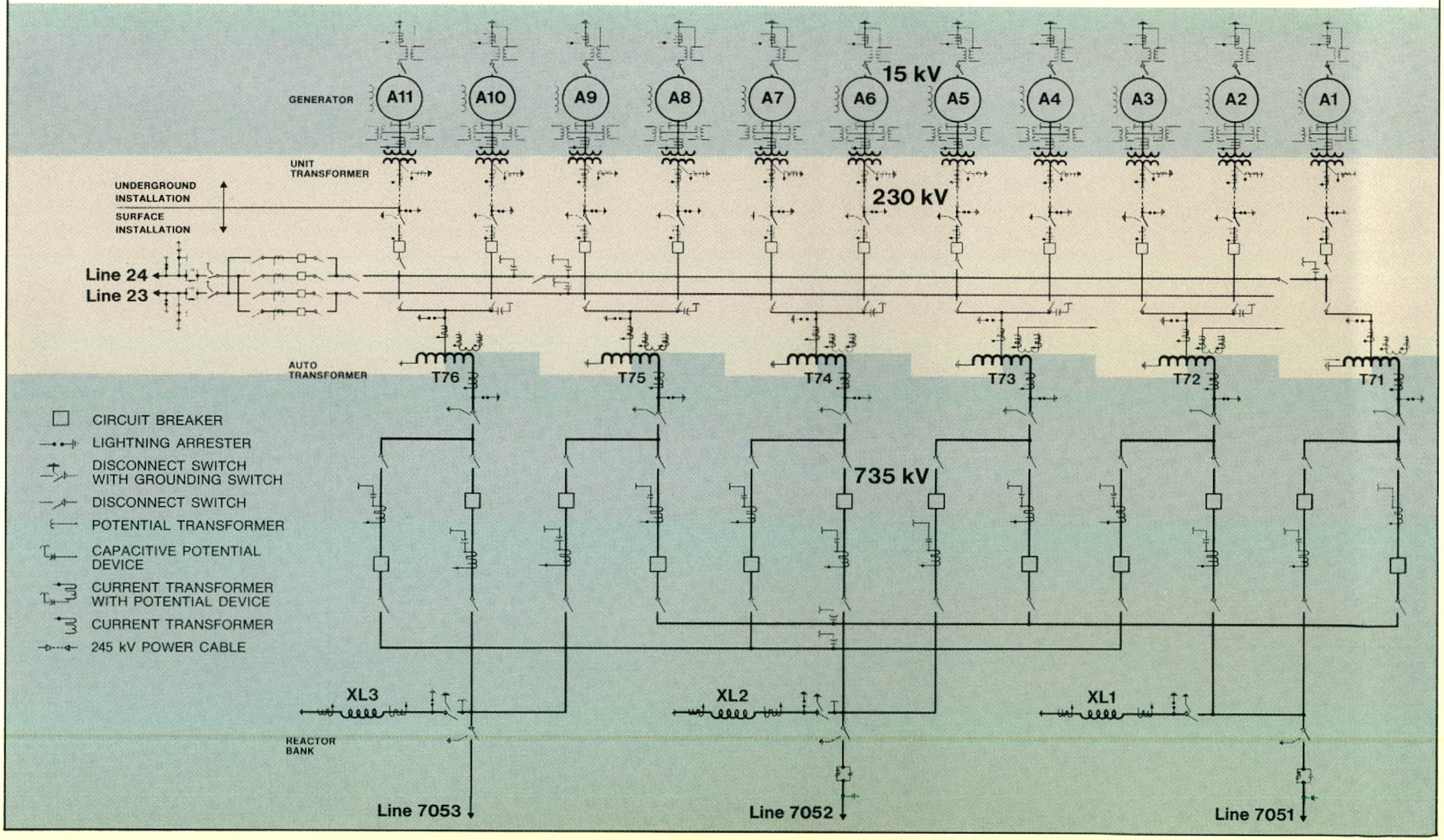
The 735 kV switchyard has a multiple ring arrangement with a bus configuration limited to two levels to restrict tower height. The scheme of main electrical connections makes it possible to remove one transmission line or one piece of major equipment for maintenance without interrupting service.

Power is transmitted over a distance of 126 miles to the point of delivery to Hydro-Quebec. There are three 735,000-volt transmission lines, each carrying three phases in bundles of four 1.2-inch diameter steel-reinforced aluminum conductors.

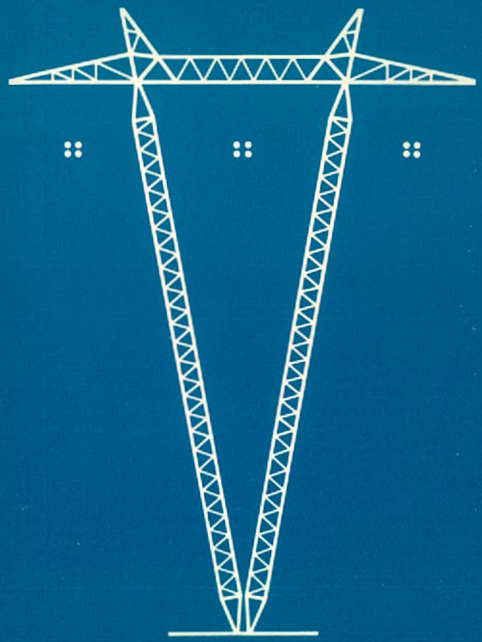
The generating units are normally operated in the automatic mode from the surface control room. Manual control of the main units and their auxiliaries is provided from the generator floor at each unit. All circuit breakers in the switchyards are controlled from the control room with position indication continuously displayed at Hydro-Quebec's Eastern dispatching office.

Water flow from the reservoir is regulated from the Churchill Falls control room. A computerized data logging system is located in the control room which continuously monitors off-limit conditions and logs statistical data. The communication systems providing the required control and protection facilities between the generating station and Hydro-Quebec's electrical networks consist of a 12-hop microwave system with 2 hops using the tropospheric scatter method of propagation, and power line carriers system consisting of 3 links on the 735 kV transmission lines.

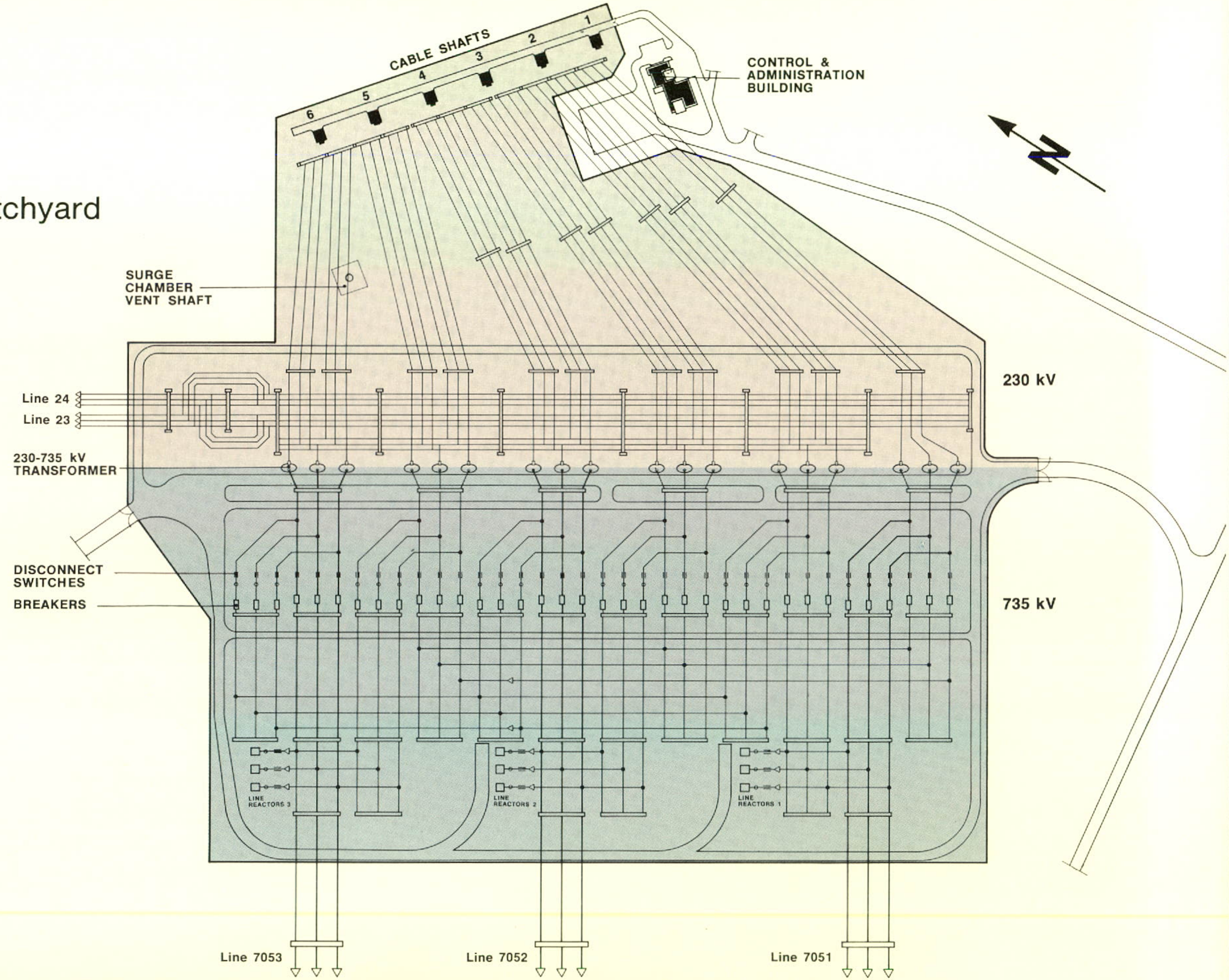
Single line diagram

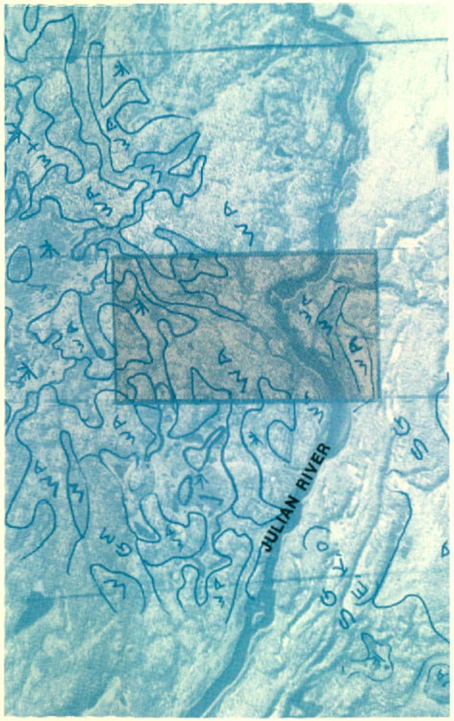


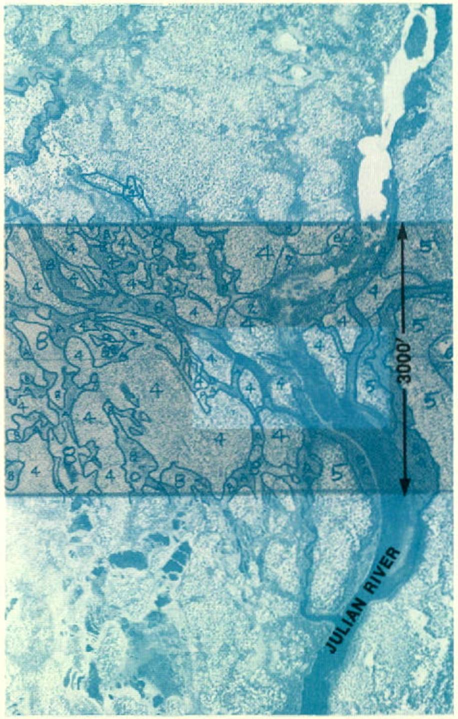
The transmission facility

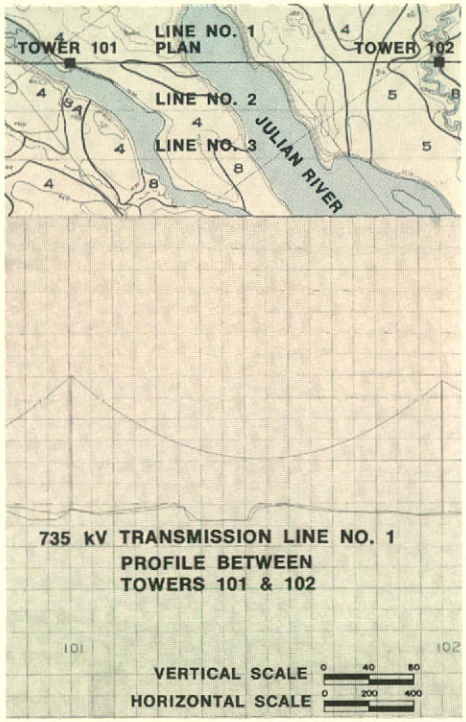


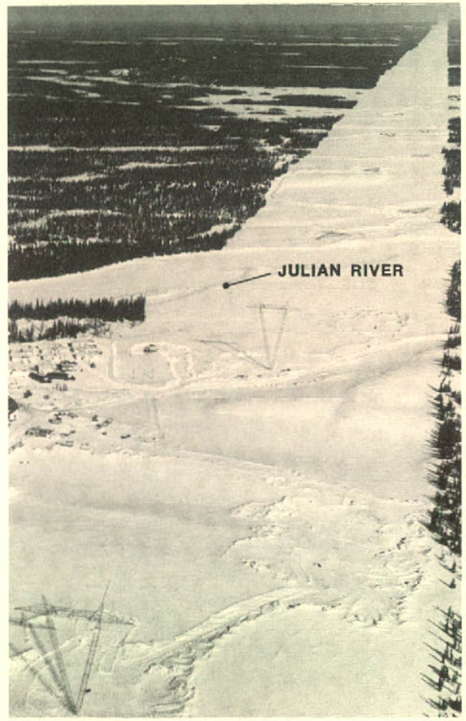
Switchyard


CABLE SHAFTS
1
2
3
4
5
6
CONTROL & ADMINISTRATION BUILDING
SURGE CHAMBER VENT SHAFT
230 kV
Line 24
Line 23
230-735 kV TRANSFORMER
DISCONNECT SWITCHES
BREAKERS
735 kV
LINE REACTORS 3
LINE REACTORS 2
LINE REACTORS 1
Line 7053
Line 7052
Line 7051





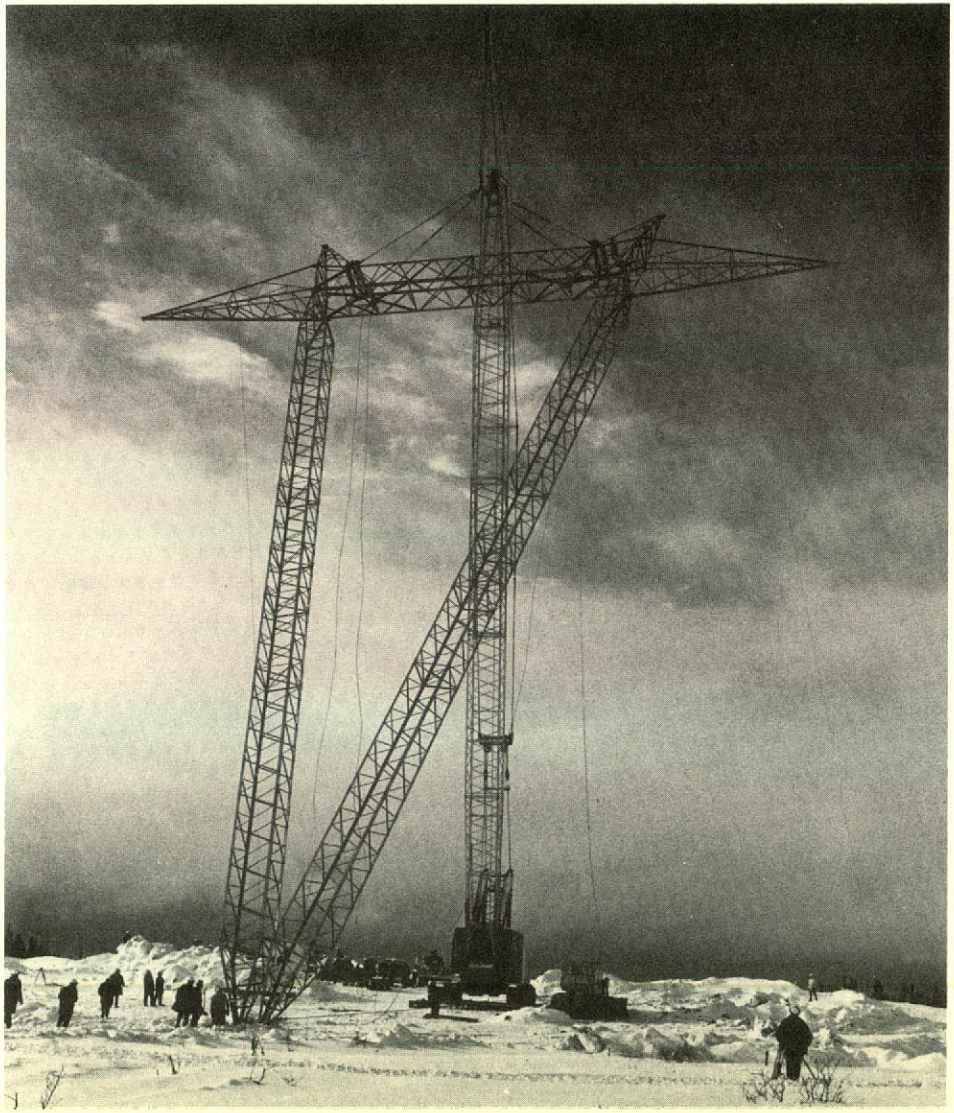


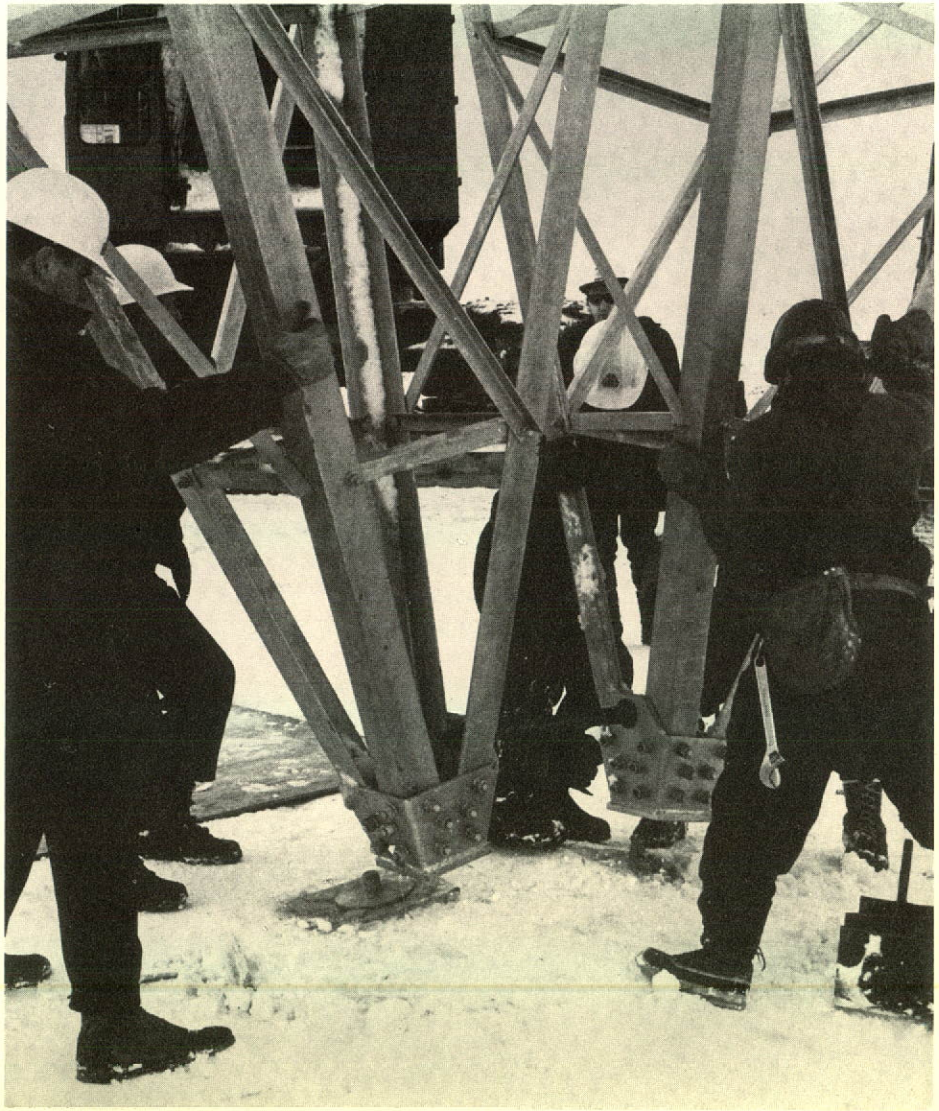


An extensive program of aerial photography, photo interpretation and photogrammetry aided engineering in the route selection and design of the 735 kV transmission lines. A preliminary five-mile wide route corridor was selected, using high altitude aerial photographs on a scale of 1:40,000.

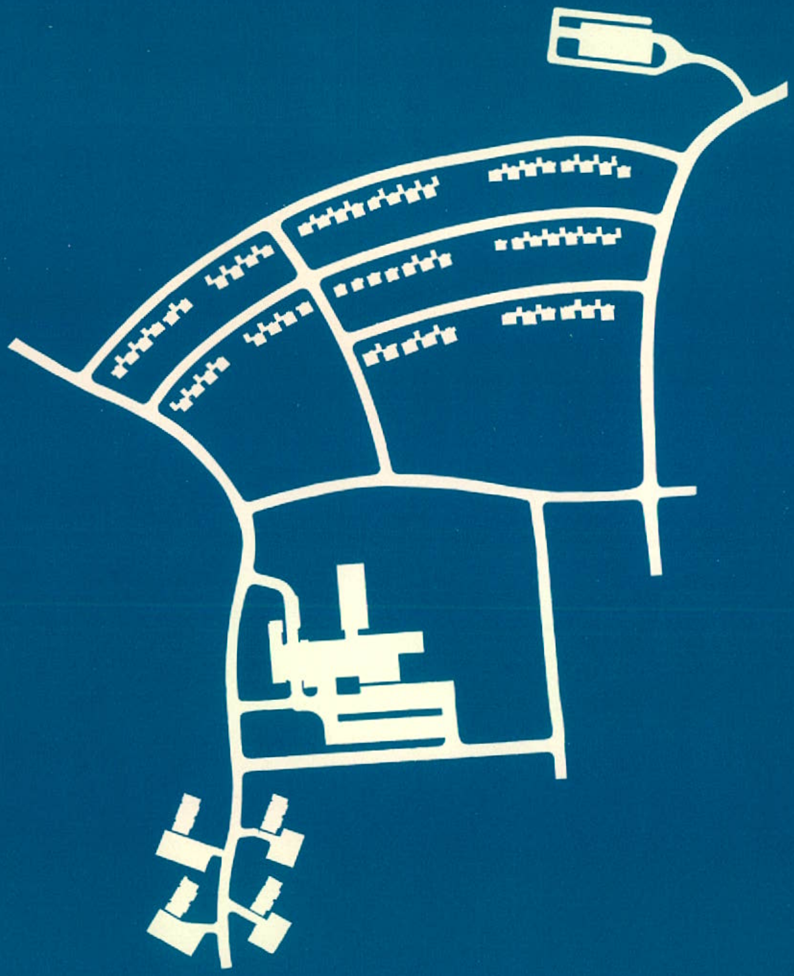
Delineation of the various soil types along a 3,000-foot wide strip, selected from the five-mile corridor, was then carried out using air photos on a scale of 1:12,000. Electro-optical survey equipment was used to establish horizontal and vertical control for photogrammetric mapping.

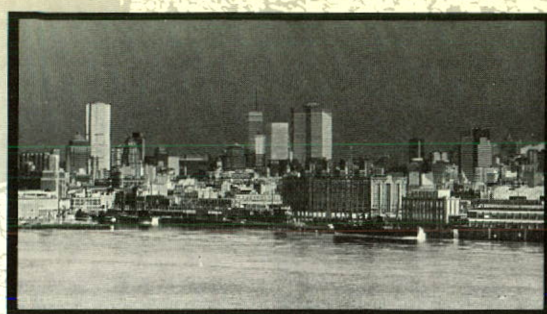
Based on the above information, a computer program was carried out for transmission tower spotting. Data obtained from photo interpretation and the computer program was checked with ground surveys and served to establish final tower positions in plan and profile. Consideration of climatic and soil conditions led to selection of V-type guyed towers. In order to reduce maintenance costs, tower foundations were designed to minimize the effects of frost heaving and all tower anchors underwent load tests prior to tower erection.





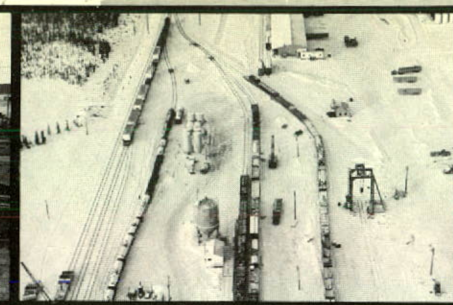
The support facility





Montreal

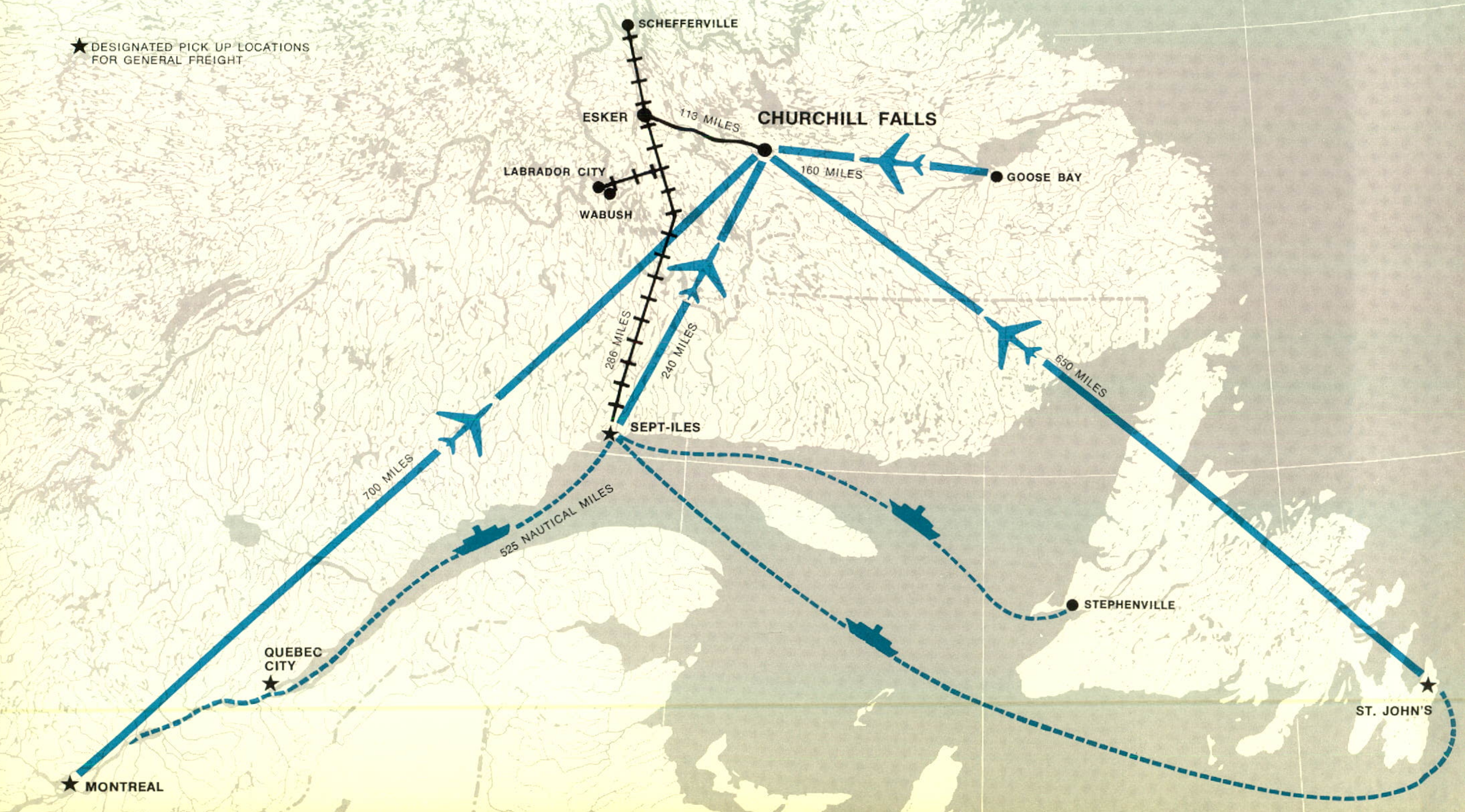
Sept-Iles



Esker

St. John's

36 Transport system



Not including the capital or maintenance costs of roads or the other permanent facilities required, the cost of General Freight Transport during construction will approximate forty-five million dollars.

General Freight

General Freight Transport involves the delivery — on schedule and in condition for use or installation — of over 650,000 tons of construction materials and equipment. This freight is consigned to twelve destination points located along 300 miles of project roads. All such transport is carried out at CFLCo's cost, under the direction of ACB. Using the freight consolidation principle, small lot shipments are avoided and advantage is taken of the most appropriate shipping equipment for single items, or mixed carload quantities.

Four designated consolidation terminals have been established, where contractors may deliver their equipment and material into the project transport system without further cost to them. These are: St. John's in Newfoundland, Montreal, Sept-Iles and, in winter, Quebec City. Montreal and points west are the source of 75% of all freight.

Three transport modes are normally required:

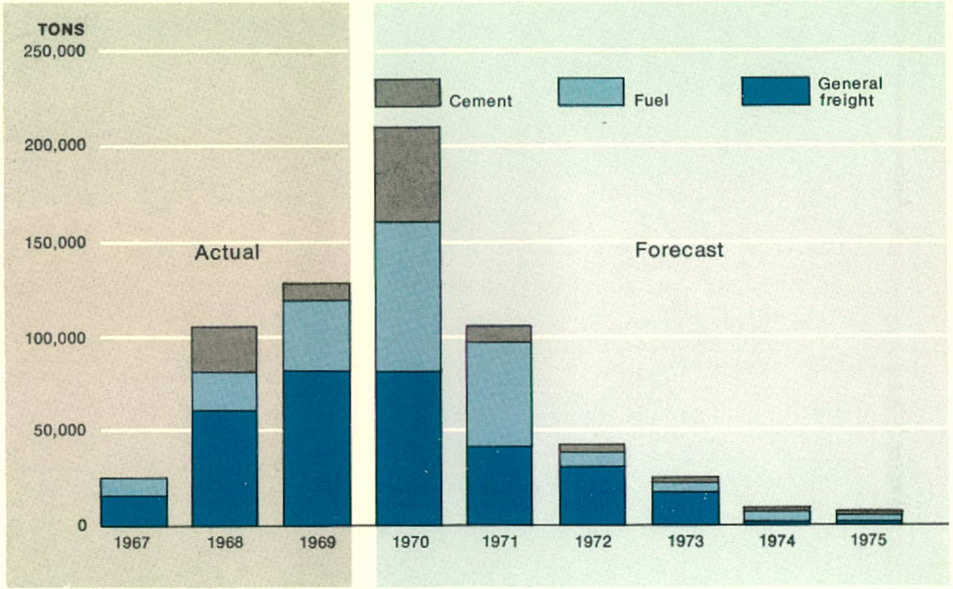
- By ship (525 nautical miles from Montreal) to Sept-Iles, with transfer to Quebec North Shore & Labrador Railway.
- By rail, 286 miles north of Sept-Iles, to Esker where transfer is made to road haulage equipment.
- By road transport to the main camp site, located 113 miles east of Esker or to other project destinations.

Transport control is assisted by a computer program which processes all shipping data and issues daily reports on the status of all items in the system.

Food is loaded into highway transport refrigerator trucks at Montreal and driven to Sept-Iles. Here the truck vans are placed on flat-deck railway cars; they are then off-loaded at Esker for road transport. Transit time for perishable foods from Montreal is 2½ days.

Some 44,000 tons of heavy-fabricated items consisting of 1,600 individual pieces of equipment ranging in weight from 25 tons up to 230 tons are moved on special railway cars and heavy-duty haulers having a capacity of up to 250 tons.

Two 250-ton cranes have been installed, at Sept-Iles and at Esker, to transfer heavy items from ship to railway car and from railway car to road hauler respectively.



Air transport of personnel, air express, and air freight

The Churchill Falls Airport is a self-contained, company-owned 150-foot wide, 5,500-foot long paved air strip located four miles west of the main town site.

The navigational aids include a non-directional beacon (N.D.B.) as well as strobe and visual aid slope indicators (V.A.S.I.).

The strip is licensed for day and night commercial operation for jet aircraft.

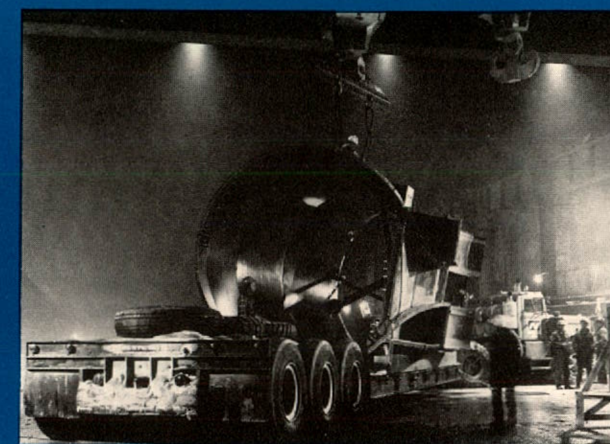
Two regional airlines, Eastern Provincial Airways and Quebecair, provide regularly scheduled daily flights to the project, from Montreal and St. John's. Approximately 125,000 passenger round-trips are forecast during the period of construction, with a maximum of 26,500 in 1970. Air Express and Air Freight will exceed 7,000 tons, with a normal maximum annual delivery of 1,500 tons in 1970.

Site transport

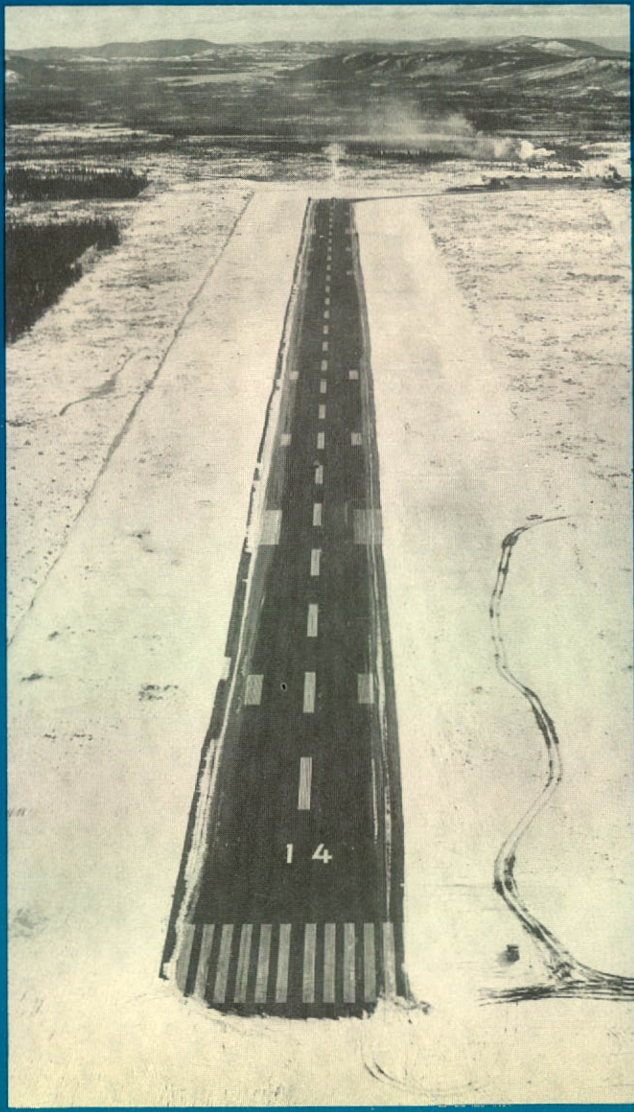
Site transport is provided by surface vehicles, wheeled and tracked vehicles, fixed-wing aircraft and several helicopters.

Helicopters are also frequently used to move equipment to certain locations normally difficult to reach.

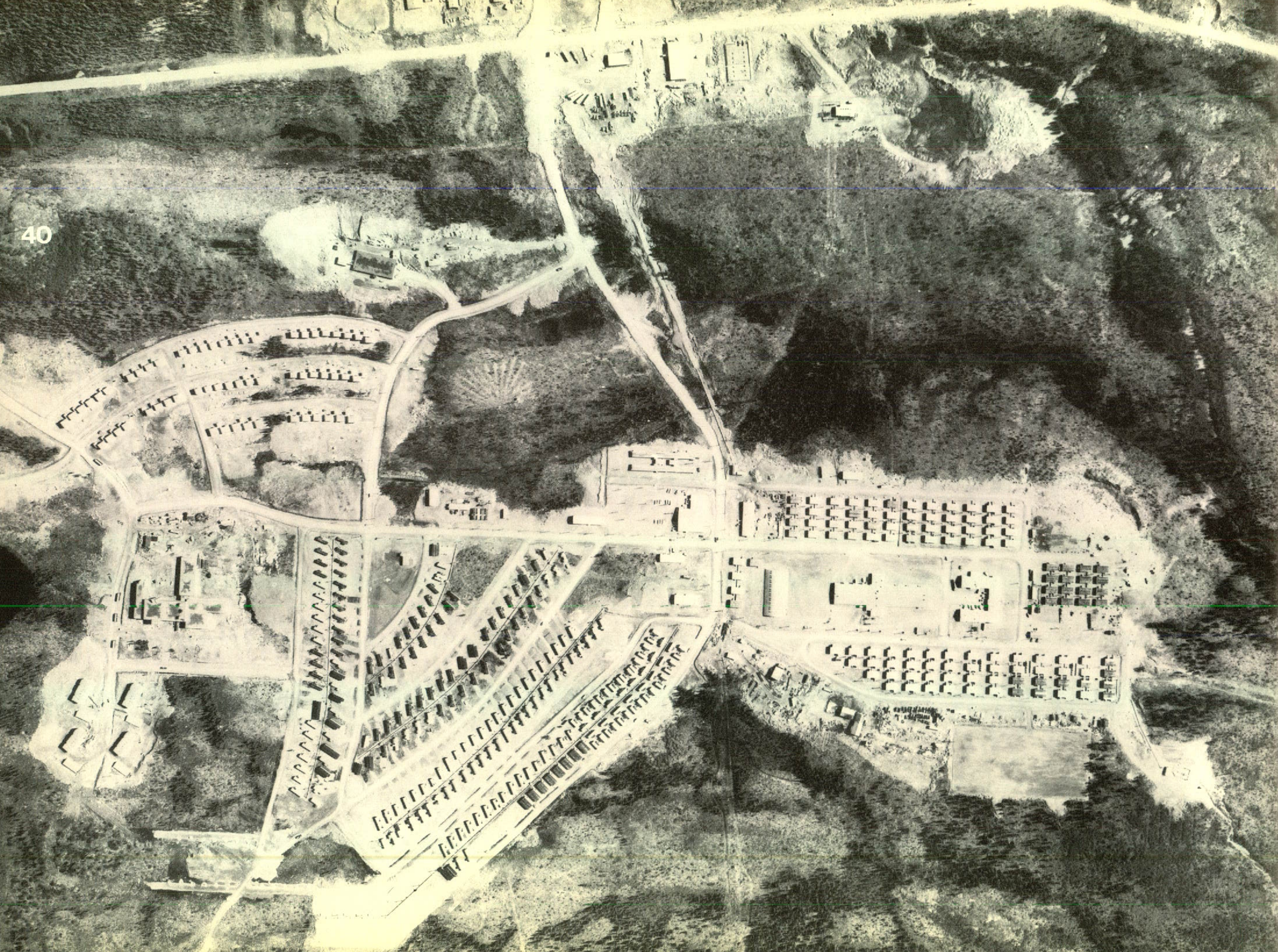
General freight



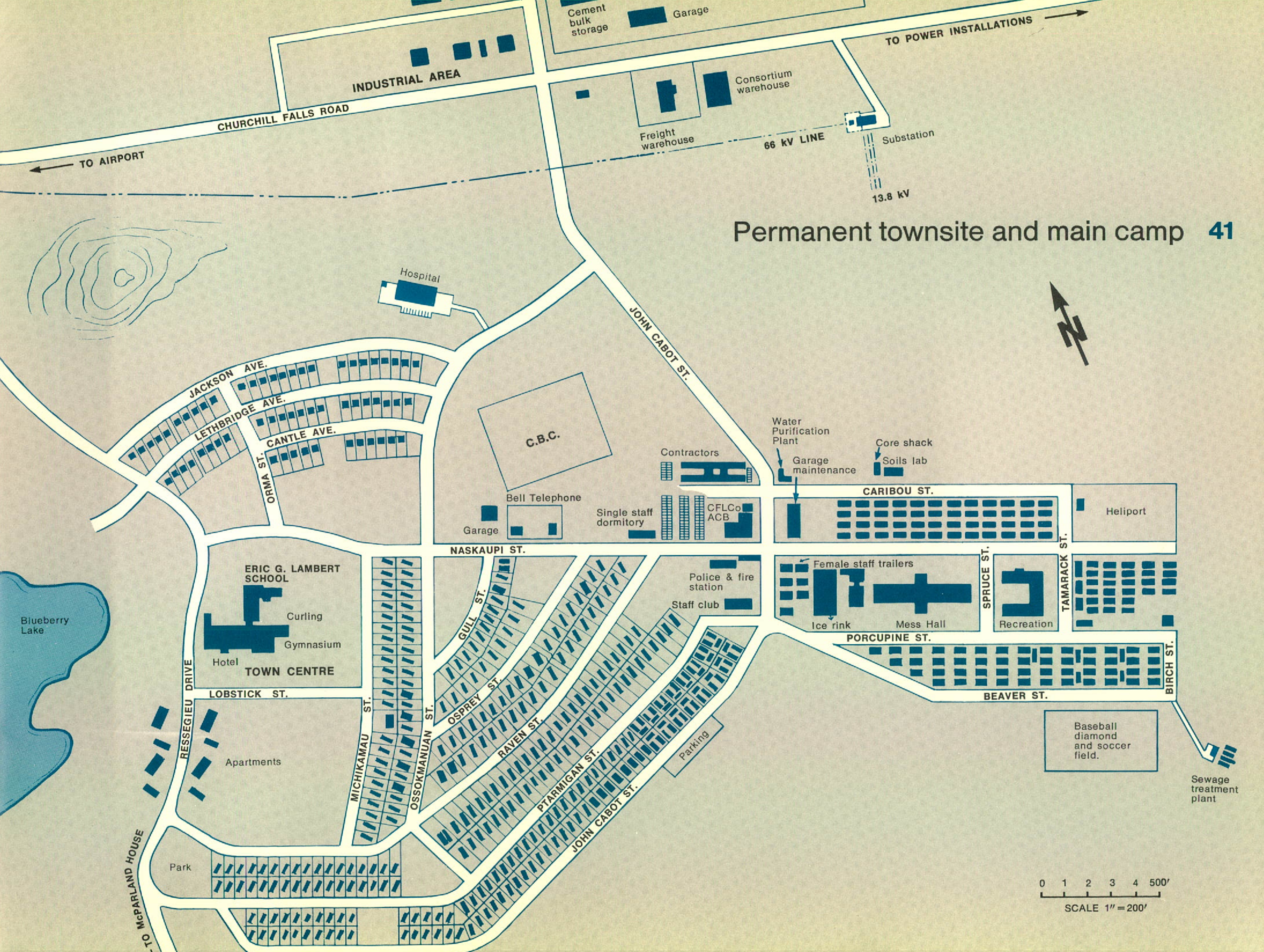

EASTERN PROVINCIAL AIRWAYS
EPA


14

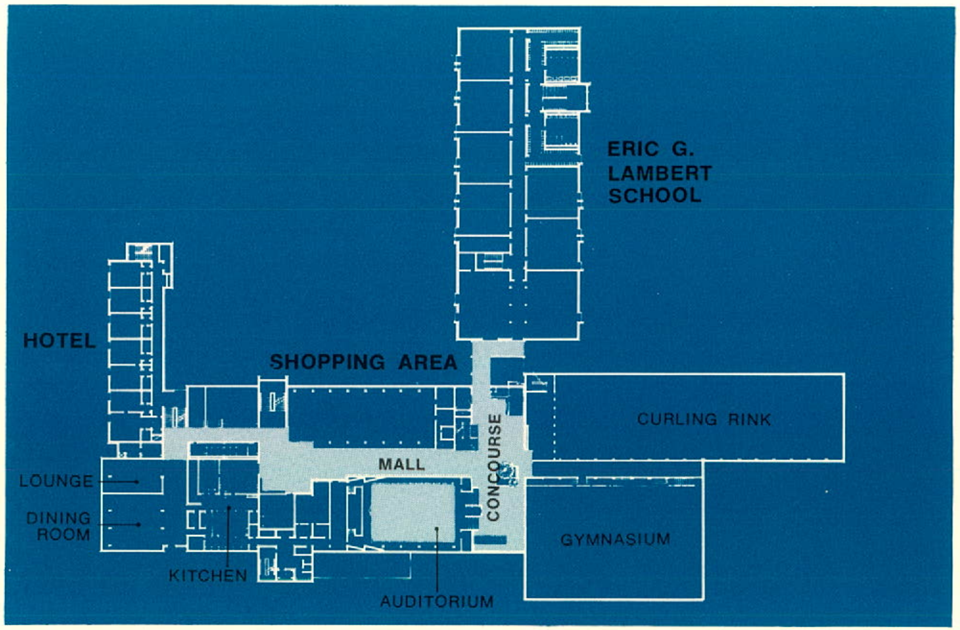

QUEBECAIR



Permanent townsite and main camp



Town Centre



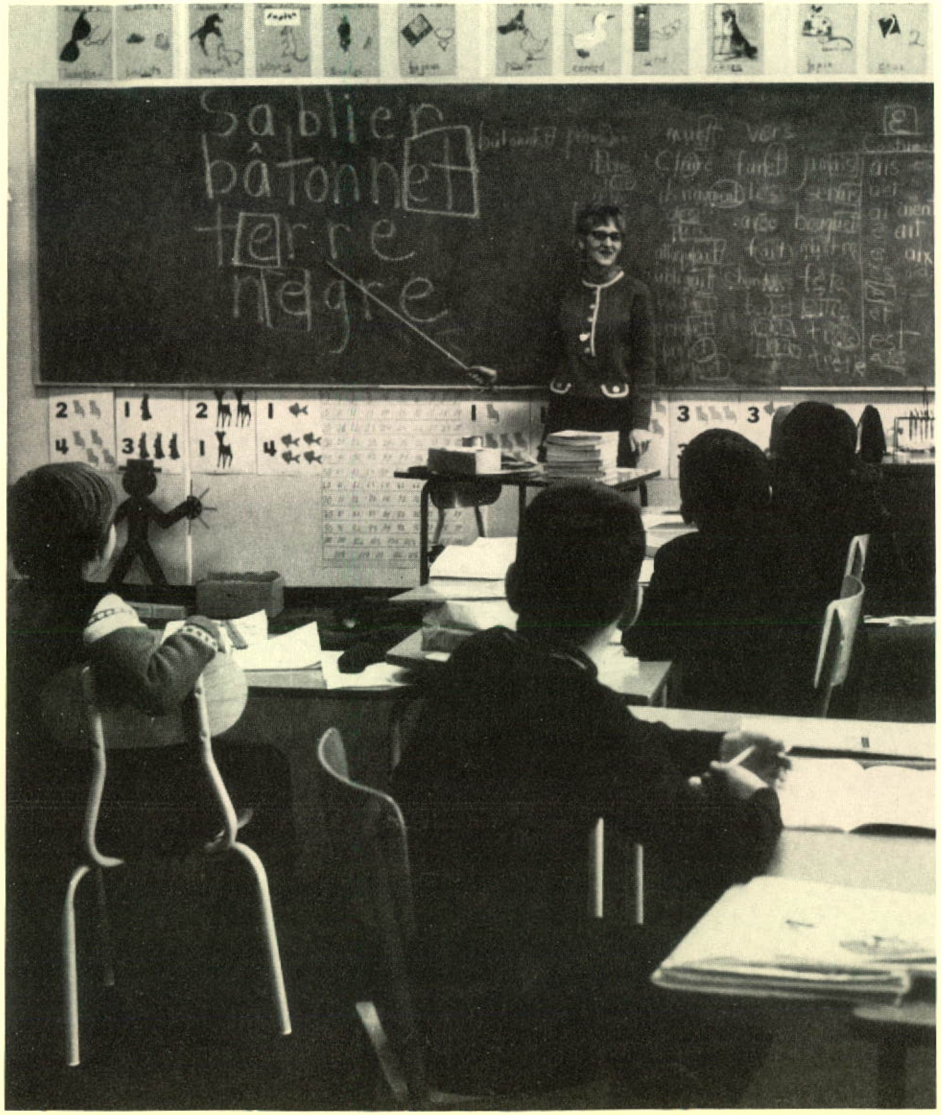
CHURCHILL FALLS PERMANENT COMMUNITY
The permanent townsite at Churchill Falls. consists of a Town Centre, 59 houses, and four 12-unit apartment buildings. The Town Centre groups under one roof most of the indoor educational, commercial and recreational services and is the heart of the permanent community.

Town Centre In addition to the school, the shopping facilities, a 21-room hotel with a dining room and two lounges, the post office and a bank, the Town Centre includes a combined auditorium and cinema as well as a gymnasium, curling rink and bowling alleys.

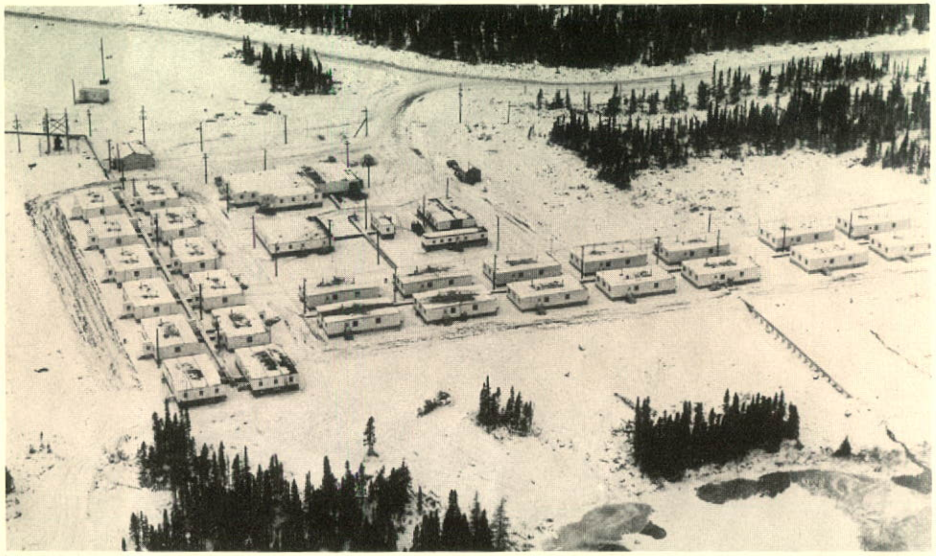
The Eric G. Lambert School, part of the Town Centre, is a private elementary school. It provides classes in English and in French and is equipped with all modern teaching aids, including a resources centre which is also the community library.

Housing Housing consists of five models of one or two storeys with three or four bedrooms. All have full basements and are built on only one side of the street to provide privacy, take advantage of the southern view and exposure, and permit snow clearing equipment to avoid build-up of snow banks in the front of the houses.

Recreation The main camp and outcamps contain service and recreational facilities. At the main camp, these include a commissary, post office, bank, barber shop, laundry and dry cleaning facilities, a 600-seat tavern, a movie hall, games rooms and television lounges. Outdoor sports are organized summer and winter.


sablier
bâtonnet
terre
nègre

44 Permanent homes and hospital



Hospital A permanent, fully equipped regional public hospital, built under joint sponsorship by CFLCo and the Newfoundland Department of Health, is operated by the International Grenfell Association.

Family trailers Accommodation during the construction period is provided for 200 families, in a trailer court which adjoins the main construction camp. This court, located between the construction camp and the permanent community, has close access to both the main camp and the school as well as to other facilities provided in the permanent Town Centre.

The main construction camp The main construction camp has accommodations for 3,000 single-status men and women. They are housed in fully serviced modern complexes consisting of three integrated trailer units. These provide 10 two-bed rooms with a central core for washroom and laundry facilities.

Out-camps There are nine construction out-camps or satellite camps serving work areas, which are remote from the main camp site. While the number of men they can accommodate ranges from a few dozen to many hundreds, all are self-contained work communities. All use the same basic 20-man trailer-complex design. Trailer kitchens, dining complexes, recreation rooms and first aid units are sized and arranged to meet changing requirements. All camps have their own water supply and sewage treatment system.

Industrial park An industrial park, where equipment and parts suppliers can set up service centres, is located just north of the main construction camp. In the same general area are cement storage and bagging facilities, fuel storage, warehousing and other facilities.

Utilities The main camp and permanent community are served by an interconnected gravity-fed water system. The water is filtered, purified and chlorinated. All sewage is treated and the effluent chlorinated.

The permanent community's water and sewage services are located below ground. Temporary trailer utility lines are housed in water-tight insulated wooden frameworks called utilidors. Thermostatically-controlled heating cables prevent freezing. The utilidors also serve as winter walkways.

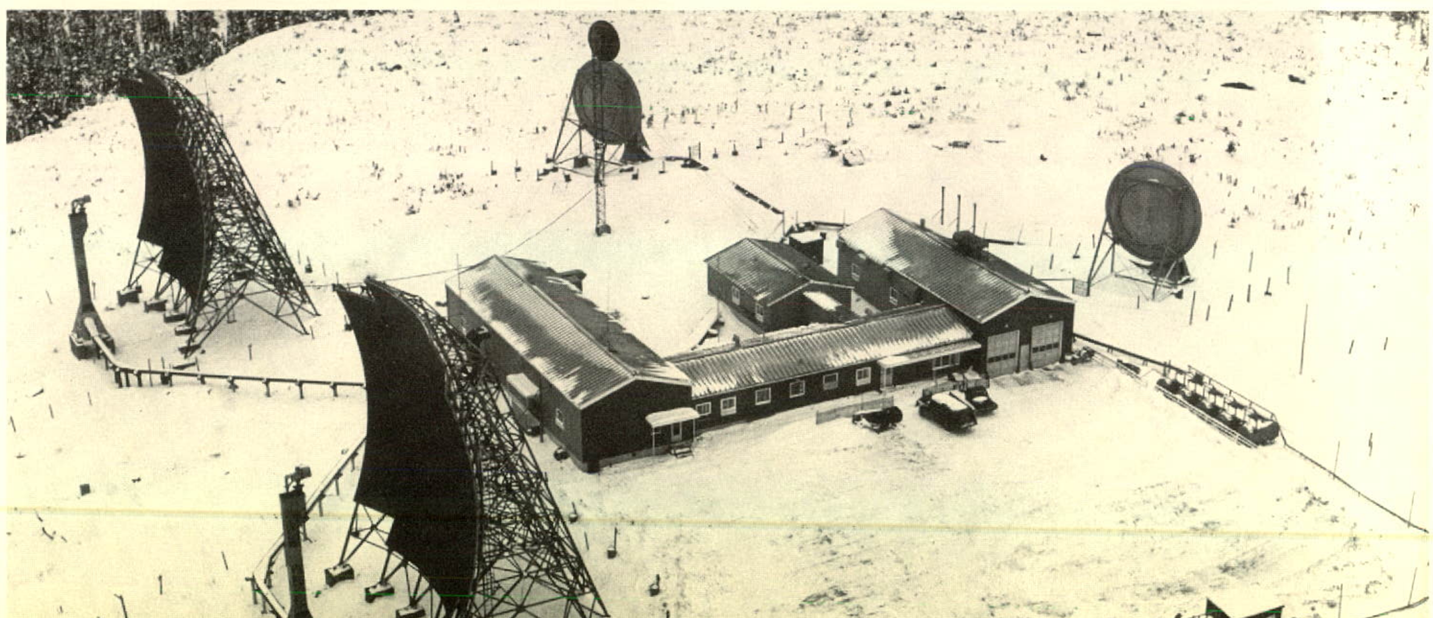
Services and communication

Communications All major work sites are connected by Bell Canada to the North American telephone network. This is achieved through a link with Bell's tropospheric scatter system serving Northeastern Canada. It makes direct-dialing long-distance service available to more than 750 project telephones. Bell also provides TWX facilities, mobile radio telephone service and a local emergency fire and security reporting system. Canadian National provides telegraph and Telex service.

The Canadian Broadcasting Corporation operates radio relay stations in English and in French at the main camp as well as video-tape television service, also in the two languages.

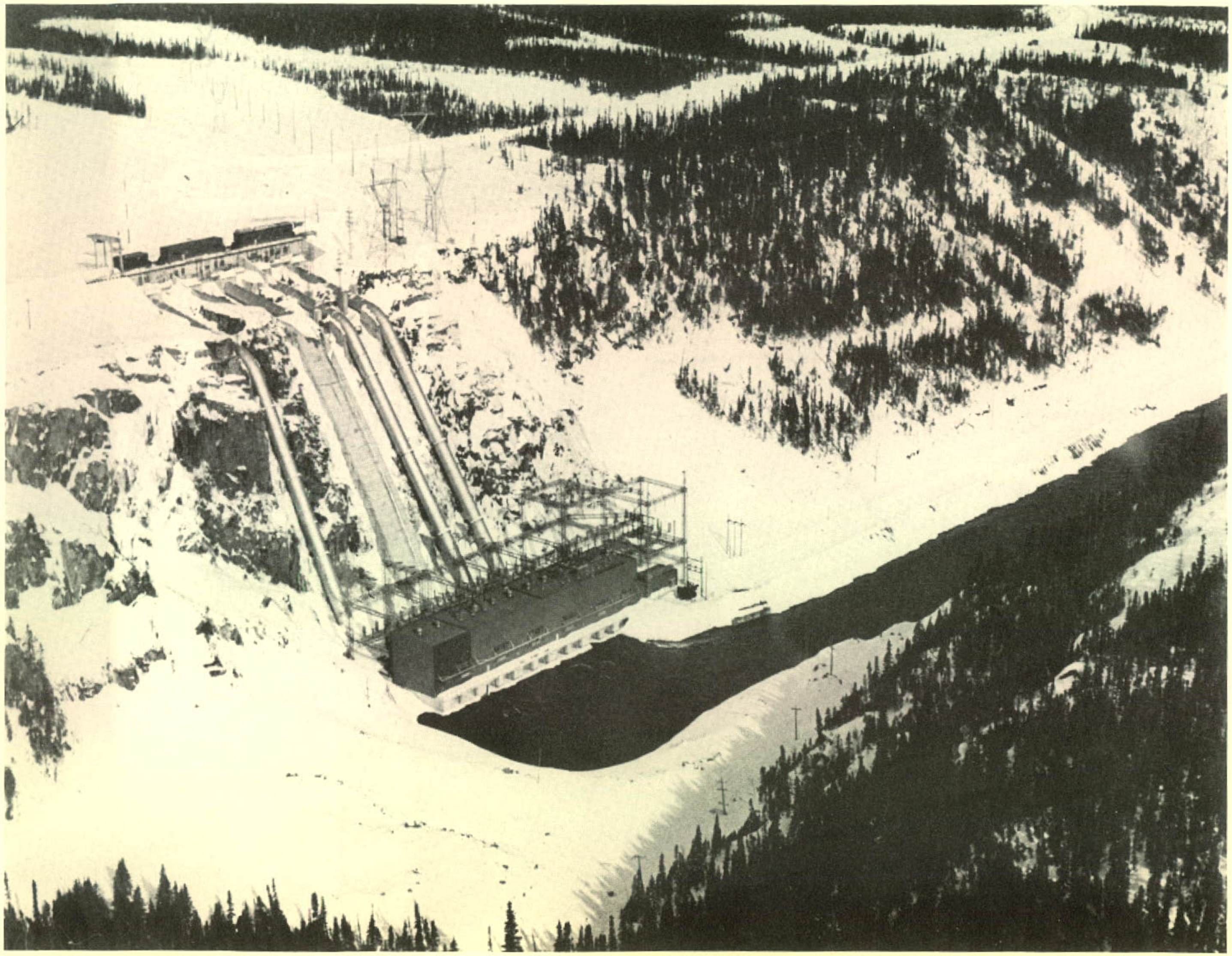
1

2



3

1. Heat tracing for water and sewage lines in a utilidor.
2. Television transmitter.
3. Bell Canada's communication system.



Power supply Most of the construction power is supplied by the nearby Twin Falls plant over a network of 66 kV lines to the main camp and a number of other major work sites. Standby diesel units are maintained. The Twin Falls plant on the Unknown River, has an operating head of 300 feet and a total capacity of 307,000 H.P. from five units. It was developed primarily to meet the power needs of iron mining in Western Labrador. Its Reservoir will form a part of the Churchill Falls reservoir when the latter development is completed.

" . . . As we face this challenge, and get on with the job, we must accept the obligations and responsibilities of leadership. One of these is that, to the limit of our resources, we be content with nothing less than the maximum effort of which we are capable. I think we will be judged, not so much on the simple magnitude of our contribution, but on its quality . . ." *D. J. McParland (1929-1969)*

The future

Before long, the waters of the Upper Churchill, dropping more than 1,000 feet from the plateau, will spin the turbines of the world's largest underground power plant. Here, near the twin tailrace outlets, as the river recommences its eastward flow to the Atlantic — more than 230 air miles away — its water surface is still over 400 feet above sea level.

As we now look to the future, it is fitting that McParland House — shown here overlooking the new beginning of the lower river — should commemorate one of those, whose unique combination of enthusiasm for enterprise and professional competence firmly established the base for the continued growth of power from Labrador.

W. D. Mulholland

W. D. Mulholland, Jr.
President and Chief Executive Officer.

CHURCHILL FALLS
(LABRADOR) CORPORATION LIMITED

Head Office
1 Viking Road, St. John's
Newfoundland, Canada.

Executive Office
One Westmount Square, Montreal 216
Quebec, Canada.

Cette publication a aussi été éditée en français.

LITHO CANADA ΔOOO INC.