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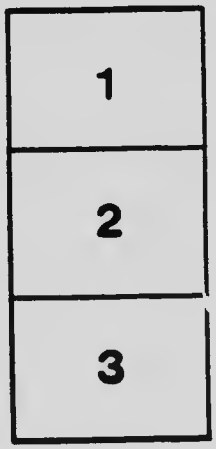

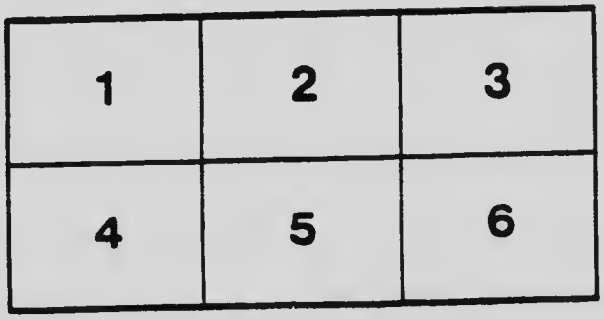

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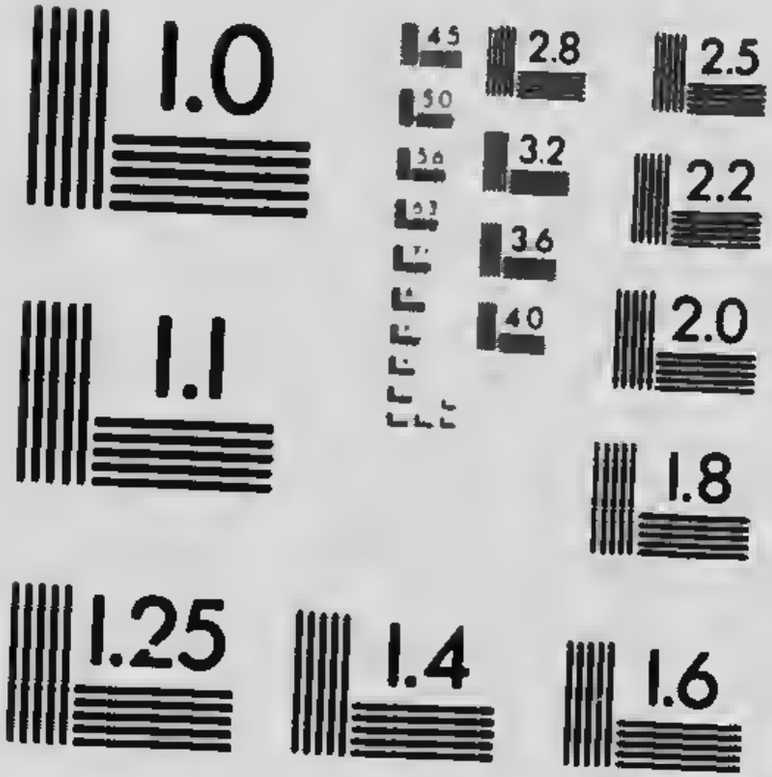

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Water Powers of Canada

The

Province of Ontario

By H. G. Acres

Department of the Interior, Canada.

HONOURABLE W. J. ROCHE, MINISTER

W. W. CORY, C. M. G., DEPUTY MINISTER

Water Power Branch

J. B. CHALLIES, SUPERINTENDENT

"An examination of any good map of our broad Dominion, reveals, as its most striking feature, an extraordinary wealthy and remarkably uninterrupted succession of lakes and rivers, suggestive of ample rainfall, the first great requisite in the occupation of any country. Over a length of several thousand miles, between Lahrador and Alaska, and over a width of several hundred miles, there is an almost continuous distribution of lakes; lakelets and rivers; the lakes of varied outlines, dimensions and elevations above sea level, and many possessing facilities for the storage of their flood waters. In many places the outlet from the lake or the connection between a chain of lakes is a narrow cleft in rock where an inexpensive dam will hold back the water supplied by the winter's accumulation of snow."

◆ ◆

From a Presidential address on the Water Powers of Canada before the Royal Society of Canada, in 1898-99, by the late T. C. Keefer, C.E., C.M.G., Honorary Member of the Institute, American Society and Canadian Society, of Civil Engineers, Past President of the American and Canadian Societies of Civil Engineers.

Water Powers of Canada

The

Province of Ontario

By H. G. Acres

Dominion Water Power Branch
Department of the Interior
Ottawa, Canada

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THIS monograph on the Water Powers of the Province of Ontario, published by direction of the Honourable W. J. Roche, Minister of the Interior, Canada, was written by H. G. Acres, B.A.Sc., Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, at the request of the Superintendent of the Dominion Water Power Branch, for distribution in connection with the water power exhibit of the Dominion Government in the Canadian Pavilion at the Panama-Pacific Exposition.

This water power exhibit was prepared by the Dominion Water Power Branch under the direction of the Commissioner General of Canadian Exhibitions, with the object of showing visitors to the exposition the tremendous water power resources of Canada, and especially the great progress already made in the art of power development and use throughout the Dominion.

The outstanding feature of the water power situation in Canada is the fact that practically all industrial and commercial centres in the Dominion, from coast to coast, have sufficient potential water power within easy transmission radius and of sufficient capacity and assured economic feasibility of development to meet all anticipated requirements for the future.

INTRODUCTION

THE greater industrial centres of the Province of Ontario lie along the shores of the Great Lakes, the nucleus of growth having been supplied by agricultural settlement, subsequent development being largely due to the unequalled facilities for inland navigation. afforded by these great bodies of water, and by the canalization of their connecting rivers. Up to 15 years ago the prosperity of the Province rested upon transportation by water, upon the development of the agricultural and lumber industries and upon Pennsylvania coal. Since that time the Sudbury, Cobalt and Porcupine mining districts have been added to the list of provincial assets. Then came the commercial utilization of the immense power resources of Niagara, resulting largely from the rapid advancement of the art of high voltage transmission.

The development of Niagara power has marked an epoch in the industrial history of the Province, not only through the displacement of steam generated power, but by reason of the fact that the availability of large quantities of cheap water, generated power has served to transform laboratory experiments into immense electro-thermal and electro-chemical industries.

The drainage system of the Province of Ontario comprises four main divisions, namely, the territory drained by the Ottawa River and its tributaries, that drained by the tributaries of the Great Lakes, that drained by the rivers flowing into James Bay, and that drained by the Winnipeg River and its tributaries.

As the distance between the east and west extremities of the Province is 950 miles, and the distance between the north and south extremities 1,050 miles, the rivers forming the arteries of the drainage system will naturally possess variant characteristics. The extremes are represented, on the one hand, by the gently flowing rivers and creeks of the south-western peninsula, and on the other by the slack-water pools and turbulent rapids and falls of the Laurentian rivers along the north shore of Lake Huron and Lake Superior. Between these two extremes, each possessing characteristics peculiar to themselves, lie the rivers in the limestone region of the eastern counties and the large rivers which reach tidewater by way of James Bay and the Hudson Sea.

WATER POWERS OF ONTARIO

OTTAWA RIVER AND ITS TRIBUTARIES

FROM a hydraulic standpoint the more important rivers tributary to the Ottawa are the Mississippi, the Madawaska, the Bonnechere, the Petewawa and the Montreal. The territory drained by these rivers at one time maintained a great lumbering industry, and while a small amount of merchantable timber is still standing, the lumbering industry does not now, and probably never will again, contribute materially to the prosperity of the district. The removal of the virgin forest has undoubtedly influenced the regimen of the streams, but the effects of deforestation have been to a certain extent neutralized by the development of second growth timber. This beneficial influence will probably be permanent, owing to the fact that the territory drained by these rivers is for the most part unsuited for cultivation and the extent of the forest cover is likely to increase rather than diminish. As a matter of fact the interests of this territory would be well served if all the Crown Lands in the upper basins of the Mississippi, Madawaska, Bonnechere and Petawawa Rivers were withdrawn from settlement, and a forest reserve established with the particular object of maturing the second growth of white and red pine, which is springing up throughout the district.

The basins of these rivers contain a considerable proportion of lake and marsh, and their flow characteristics are susceptible of material improvement through the agency of artificial storage. The gradient of the streams themselves is generally steep, and concentrated natural heads, ranging from 20 to 100 feet, offer numerous opportunities for cheap development. The power capacity of these rivers is, however, not comparable to that of the Quebec tributaries of the Ottawa, owing to their generally smaller drainage areas. The basin of the Madawaska, the largest Ontario tributary, has only about one third of the area of the Gatineau basin, which is the largest Quebec tributary. For this reason, instead of natural capacities of 10,000 h.-p. and over, such as are common in Quebec, the Ontario tributaries offer facilities for the development of capacities ranging from 1,000 to 5,000 h.-p. only, except in one or two isolated cases. One exception is the High Falls on the Madaswaska, where the natural head can be increased to 150 feet, and 12,000 h.-p. developed under natural flow conditions, and probably 20,000 h.-p. with artificial storage.

The status of these water powers as regards possibility of development is peculiar and unfortunate. With the possible exception of the High Falls site, their individual capacities are not sufficient to justify development for long distance transmission, and at the same time are generally too great to permit development for local markets, most of which are now adequately supplied by existing developments of small capacity immediately adjacent to the point of consumption. Such development has taken place on the lower Mississippi at Carleton Place, Almonte and Galetta; on the Rideau at New Edinborough, Perth, Smith's Falls, Merrickville, and Andrewsville; on the Madawaska at Bancroft, Arnprior and Mountain Chute, and on the Mattawa at Mattawa. These developments have capacities

Hound Chute Power House, Montreal River (Interior View), Cobalt District.

ranging from 40 to 1,000 h.-p. and supply power to a large number of labor using industries which contribute materially to the prosperity of the municipalities in which they are located. Renfrew, particularly, is developing into a flourishing industrial centre as a result of power development on the Bonnechere, the business being divided between the recently completed municipal plant having 700 h.-p. capacity and the 750 h.-p. plant of the Renfrew Power Company. To meet the present and future requirements of the power users on the Bonnechere River and on their behalf, the Hydro-Electric Power Commission has constructed a storage dam at Round Lake, and has reported as to the feasibility of creating additional storage should the same be required.

Chaudiere Falls, Ottawa River, and Twin Falls, Rideau River.

In connection with the development of power in the Ottawa Valley the important developments of the Northern Ontario Light & Power Company deserve special mention. This company supplies power to the mines in the Cobalt district, and it is a notable fact that the introduction of hydro-electric power has caused the use of steam to be almost wholly discontinued for the operation of mines. In 1909 the camp imported 63,739 tons of coal, between June and December. In 1910, subsequent to the advent of hydro-electric power, only 17,349 tons were imported during the same period.

This company has two hydro-electric plants in operation, one on the Metabitchewan operating under a head of 312 feet, with 8,000 h.-p. installed, and one at Round Chute on the Montreal River, operating under a head of 33 feet and with 3,800 h.-p. installed. The power is transmitted to Cobalt, and the vicinity, over wood pole transmission lines 25 and

17 miles long respectively, the transmission pressure being 44,000 volts in the first case, and 11,000 volts in the latter. The distribution of the average load is approximately as follows:

Electric Railways 400 h.-p., domestic and commercial light 200 h.-p., mining load 10,000 h.-p.

The Metabitchewan site is now fully developed, and any additional power required by the Cobalt camp must be supplied from the Montreal River. The most important undeveloped site on this river is that known as the "Notch," where a head of 100 feet is available, and where about 7,000 h.-p. can be developed under ordinary low water conditions. These are commercial possibilities in connection with the development of this water power which merit serious consideration.

Concerning the Ottawa River itself, mention has previously been made of the fact that with regulated flow, 600,000 h.-p. will be available to Ontario, between Lake Temiskaming and Carillon. This aggregate capacity will be capable of commercial development only in the event of the river being canalized, and will depend furthermore upon the creation of a market for power vastly in excess of that now existing.

Power development on the Ottawa River, in Ontario, is at present almost wholly confined to the large industries which operate at the Chaudiere Falls, and under average conditions about 36,000 h.-p. is now in use. Of this amount about 17,000 h.-p. is used in the mills of J. R. Booth, 5,000 h.-p. by the Ottawa Power Company, 9,000 h.-p. by the Ottawa Electric Company, and the balance by the city waterworks and the street railway.

With complete flow regulation it is anticipated that the minimum capacity of the Chaudiere will be 84,000 h.-p. or about 25,000 h.-p. in excess of the amount now developed on both sides of the river. The very considerable industrial prominence which the City of Ottawa has attained, through the development of Power at the Chaudiere, will thus be further enhanced by the future development of the surplus capacity provided by regulation.

RIVERS TRIBUTARY TO THE GREAT LAKES

FROM an economic standpoint the rivers tributary to the Great Lakes are now, and will probably continue to be, the most important of the rivers lying wholly within the boundaries of the Province. This is due to the fact that they produce motive power, either direct or through the medium of electric transmission, for a great variety of industries, many of which are large users of labor and consequently contribute greatly to the population and general prosperity of the Province.

Of the rivers flowing into Lake Ontario, the Trent is the most important. On this river and its main tributaries there is about 75,000 h.-p. capable of more or less easy development by reason of the works of the Trent Canal, which are now nearing completion. Of this total quantity about 45,000 h.-p. is now developed between Trenton and Balsam Lake, which is the summit level of the canal.

The most important developments are those of the Electric Power Company, which company has seven plants in operation, with a rated capacity of 33,300 h.-p. installed.

Healy Falls. Development of Electric Power Company. Trent System.

Auburn Power Company. Electric Power Development. Trent System.

Through the medium of about 300 miles of 44,000 volt transmission line the company supply power to a large territory, extending along the lake front from Whitby to Napanee and as far north as Madoc and Lindsay. It has also by the wholesale acquisition of local hydraulic, steam and gas plants, obtained complete control of the light and power business in the territory served by its transmission lines.

From the above figures it appears that the undeveloped hydraulic resources of the Trent system amount to almost 30,000 h.-p. The importance of these undeveloped resources is largely due to the fact that they are capable of cheap and easy utilization through the existence of the locks and dams of the Trent Canal, which concentrate all of the natural head between Trenton and Balsam Lake. In addition to this the large lake areas of the

Eugenia Falls, Beaver River.

Development of Simcoe Railway and Power Company, Severn River.

Wasdell's Falls Development, Hydro-Electric Power Commission of Ontario.

Trent basin are controlled by the Dominion Government, largely with a view to improvement of flow conditions for power purposes. The regimen of the river had previously been seriously affected by deforestation, but flow conditions have already been materially improved, and still better results are to be anticipated through the further extension of the storage system, and the development of an efficient scheme of control.

The existing market requirements of the district are now fairly met by the existing developments, but the undeveloped water powers of the Trent System, having capacities ranging from 1,000 to 10,000 h.-p., offer fine opportunities for the establishment of new industries, especially in the vicinity of Peterboro, Campbellford and Trenton.

Pipe Line for Eugenia Falls Development, Beaver River, under Construction.

At the present time the canal water powers are developed under a form of lease issued by the Department of Railways and Canals. Latterly these leases have called for a rental of $2.00 per horse-power per annum for every horse-power developed.

The Grand River is the largest of the Lake Erie tributaries, and the possession of 2,500 square miles of drainage area should properly class it among the more important rivers of the Province from a power standpoint. At the time of Confederation, and for some years thereafter, the Grand River supplied all the water used for power and navigation purposes on the Welland Canal. Since that time there has been developed in the Grand River basin one of the greatest agricultural districts in Canada, and an urban population supported by

General View of Spanish River Pulp and Paper Company's Plant.

industries of national importance. The combined effects of deforestation, drainage and extensive cultivation, which attended this industrial growth, have transformed the Grand River into a destructive torrential stream, and largely destroyed its usefulness as a source of power.

Through similar causes, the Thames, the Maitland, and most of the smaller streams in the south-western peninsula also suffer seriously from lack of natural control. An investigation is now being carried on by the Hydro-Electric Power Commission with a view to determining some feasible method of improving the regimen of these rivers, but for the time being, at any rate, they must be regarded only as sources of intermittent power for purely local purposes.

The rivers flowing into Lake Huron possess varying characteristics as regards regimen, ranging from the Maitland, with its natural flow characteristics almost completely destroyed.

and the Saugeen, which still retains in a certain degree its natural regimen, to the Laurentian rivers of the North shore, flowing from unsettled and forested basins.

The contrasted characteristics of these, Lake Huron rivers illustrates in a most emphatic manner the effect of agricultural development on stream-flow. The Maitland basin has an area of about 950 square miles, almost entirely deforested and very highly cultivated. The measured minimum run-off of this river is to its measured maximum run-off as 900 to 1. The Wahnapitae River on the north shore has practically the same area as the Maitland. The basin of this river is largely in virgin forest, and second growth, and practically unsettled. Its maximum run-off is to its minimum run-off about as 10 to 1, against 900 to 1 for the Maitland. Also its minimum run-off per square mile of drainage basin is about 13

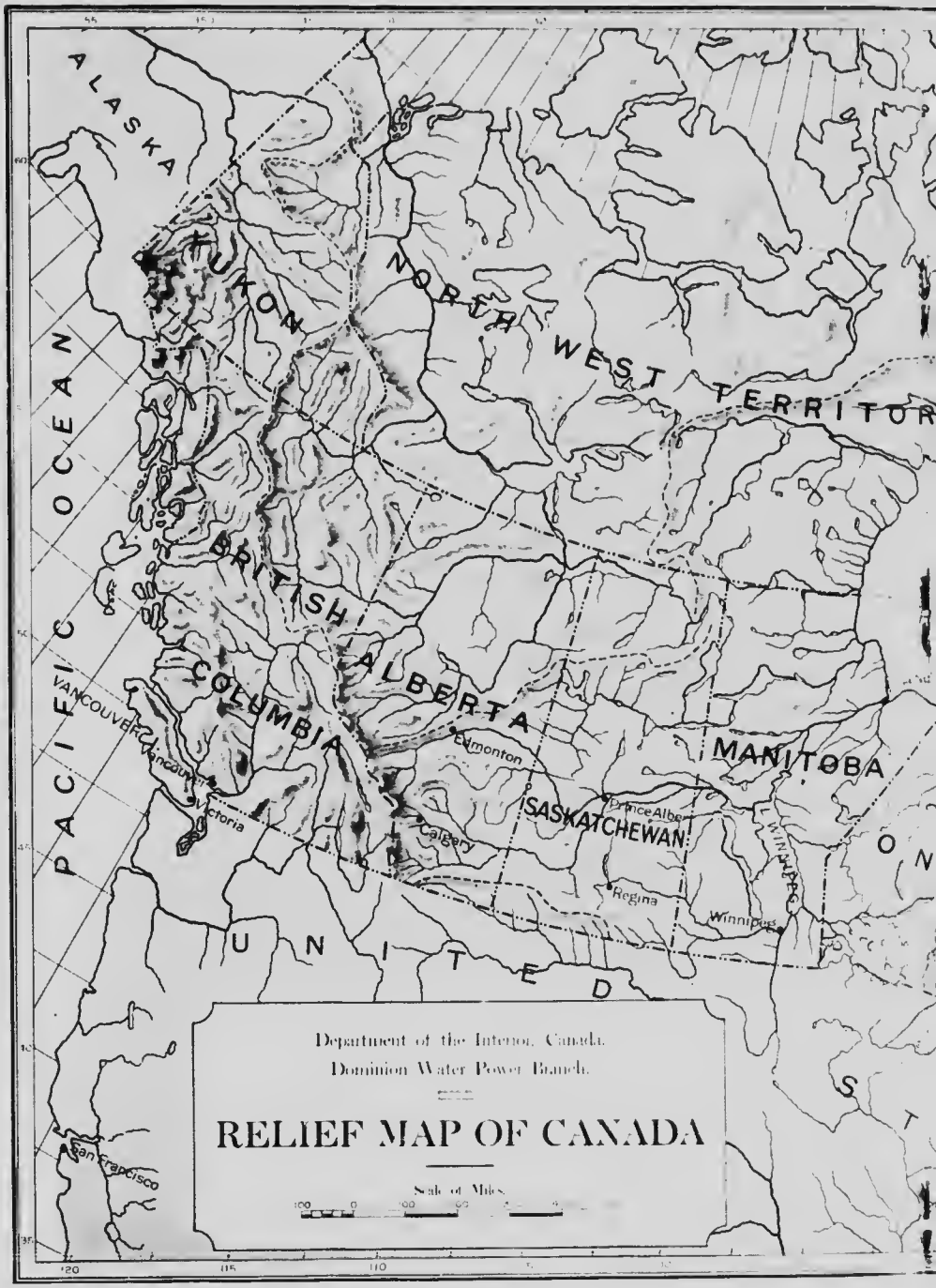
Eugenia Falls Development.
Pipe Line under Construction from Power House Site.

Kakabeka Falls, Kaministiquia River.

times that of the Maitland. It is only fair to state that the regimen of the Wahnapitae is considerably influenced by natural lake storage, which the Maitland River lacks entirely, but even after giving due weight to this fact the contrast is startling.

From a hydraulic standpoint, the most important of the Lake Huron tributaries, are the Mississaga, the Spanish, the Sturgeon, the French, the Maganetwan, the Muskoka, the Severn, the Saugeen and the Beaver.

The total low water capacity of all the Lake Huron tributaries is about 166,000 h.-p., this figure being reasonably conservative as it does not fully take into account the affect of artificial storage. Of the above total about 56,000 h.-p. is at present developed, leaving an undeveloped surplus of 110,000 h.-p.


ALASKA
YUKON
NORTH WEST TERRITORIES
PACIFIC OCEAN
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
VANCOUVER
Vancouver
Victoria
Edmonton
Calgary
Prince Albert
Regina
Winnipeg
UNITED STATES
San Francisco
Department of the Interior, Canada.
Dominion Water Power Branch.
RELIEF MAP OF CANADA
Scale of Miles.


GREENLAND
TORIES
ATLANTIC
OCEAN
LABRADOR
HUDSON
BAY
QUEBEC
NEWFOUNDLAND
BA
ONTARIO
GULF
OF
ST. LAWRENCE
PRINCE EDWARD
ISLAND
NEW
BRUNSWICK
Quebec
St. John
Halifax
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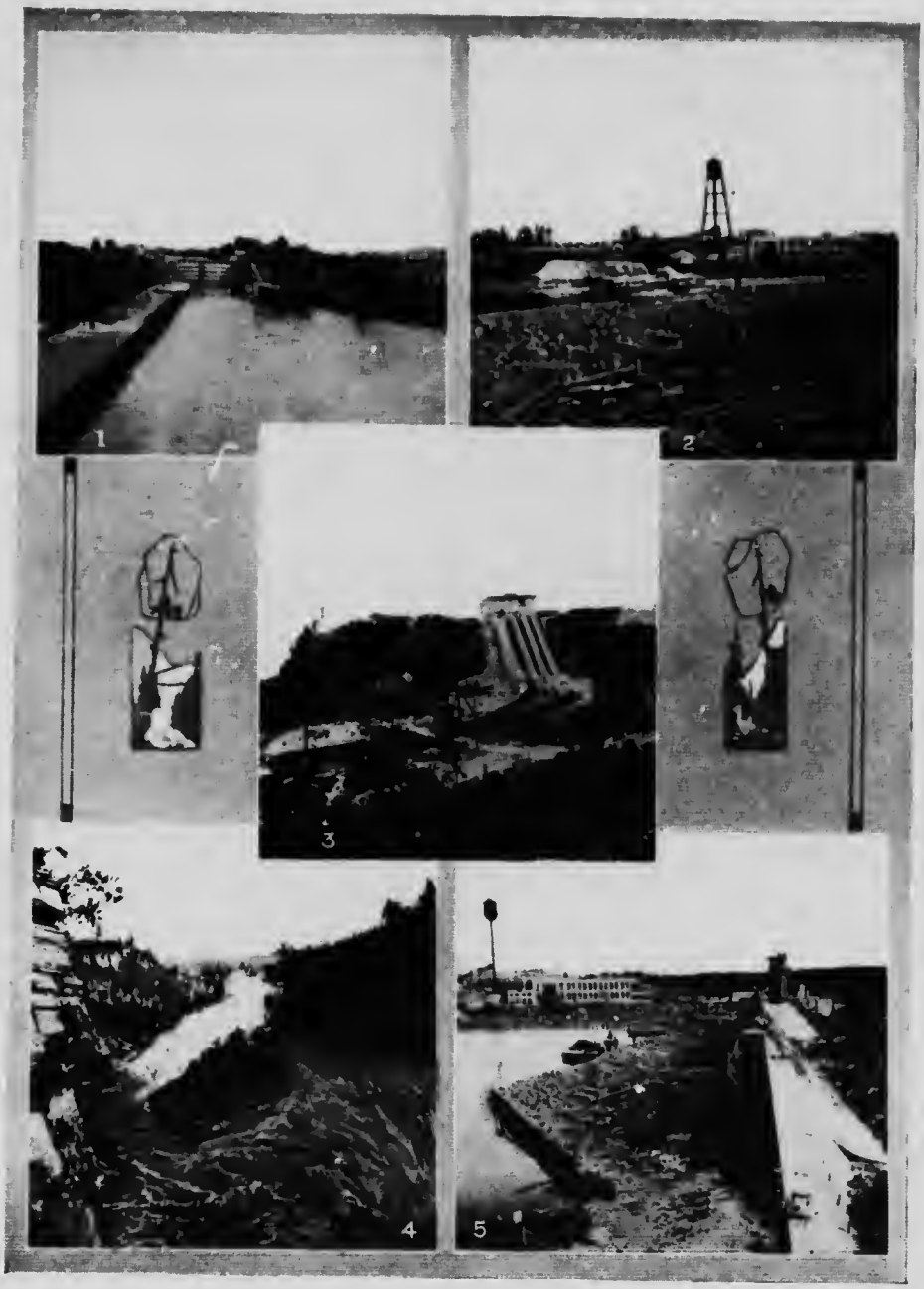


1. Canadian Lock, Sault Ste. Marie.
2. Abitibi Pulp and Paper Company's Plant, Iroquois Falls, under Construction.
3. Pipe Lines at Kakabeka Falls.
4. Gorge in Maninistiquia River, below Kakabeka Falls.
5. Abitibi Pulp and Paper Company's Plant, Iroquois Falls, under Construction.

As to industrial opportunities in this district, various quantities of power are, or will shortly be, available for purchase as follows:—

The Simcoe Railway & Power Company has some 3,000 h.-p. of surplus capacity available at the Big Chute on the Severn River.

When the new plant at Swift Rapids is built there will be 3,000 to 3,500 h.-p. available.

When the South Falls development on the Muskoka River is completed, the Towns of Gravenhurst, Bracebridge and Huntsville will have about 1,000 h.-p. for sale.

The Wahnapitae Power Company has about 2,000 h.-p. of surplus capacity for sale in Sudbury and the vicinity.

Falls on White River, North Shore of Lake Superior.

The Hydro-Electric Power Commission has now in operation a 1,200 h.-p. plant at Wasdell's Falls on the Severn River, and a 4,000 h.-p. plant is under construction at Eugenia Falls on the Beaver River.

As to wholly undeveloped powers, those on the French River are the most important in this district, there being three sites capable of development to the extent of about 10,000 h.-p. each, with the assistance of Lake Nipissing storage. The remainder of the undeveloped capacity of the district is distributed in blocks of 1,000 to 5,000 h.-p., the smaller capacities being predominant, and in many cases not sufficiently accessible for commercial development at the present time. For the possibility of development in the near future the larger of these powers must look to the mining and pulp industries, in connection with which there are now two large plants on the Spanish River. At High Falls the Canadian Copper Company has 12,500 h.-p. installed for the operation of its mines and smelters, and the

Kaministiquia Power Company's Development, Kakabeka Falls.

Spanish River Pulp & Paper Company, lower down on the river, has 10,000 h.-p. installed for the manufacture of pulp and paper.

The natural conditions and market prospects in the district, immediately south of Georgian Bay, are such that hydro-electric development and transmission offers little or no inducement for private enterprise, and for this reason, the hydraulic resources of the district have lain largely dormant up to the present time. An exhaustive investigation of conditions by the Hydro-Electric Power Commission, nevertheless, revealed the fact that if certain water powers were developed and transmission lines built, with 4½% money, and all consideration of selling profit eliminated, it would be commercially feasible to supply power to a number of municipalities on the east shore of Lake Simcoe and in the Counties of Grey and Bruce.

At the request of the municipalities interested, the Commission obtained the consent of the Provincial Government to build the above mentioned 1,200 h.-p. plant at Wasdell's Falls, which is now supplying the towns and villages on the east shore of Lake Simcoe as far south as Cannington. The 4,000 h.-p. plant at Eugenia Falls is being developed under a head of 540 feet, and it is expected that a market for this power will be found in the Counties of Grey and Bruce.

Apart from the benefits which will directly accrue as a result of the construction of these two plants, it is anticipated that the power market will, in the near future, expend sufficiently to permit the further development of the power resources of the district on a commercial basis. As a result, the district as a whole will derive immense benefit from the utilization of its own local resources to the extent of some 15,000 h.-p. of cheap power, a result which could never under any circumstances have come to pass through the agency of private initiative.

The watershed characteristics of the Lake Superior Tributaries are generally similar thoughout, as the whole area tributary to the l ' , has fairly uniform topographical features, and is generally forested with pine, spruce, balsam, birch and poplar. Owing to the proximity of the crest of the height of land to the north shore of the lake throughout the greater part of its length, most of its tributaries are short and turbulent and all have the high natural heads which characterize the Laurentian rivers. All along the north shore, on large and small rivers, natural falls 50 to 125 feet in height are common.

This territory is to a large extent unsettled, and in many localities practically unexplored, and it necessarily follows that no large proportion of its hydraulic resources will be developed in the very near future. At the present time about 20,000 h.-p. is developed out of a total potential capacity of about 195,000 h.p. Of the developed power about 4,500 h.-p. is used in the Michipicoten District for the operation of mines, 1,500 h.-p. being supplied by the Michipicoten Power Company and 3,000 h.-p. by the Algoma Steel Corporation. It is understood that the Michipicoten Power Company can increase its capacity considerably by the development of artificial storage.

The remaining 15,500 h.-p. is used in the cities of Port Arthur and Fort William, and is mainly derived from the plant of the Kaministiquia Power Company. This company has an extensive development at Kakabeka Falls, operating under a 180 foot head. This company is said to have about 15,000 h.-p. of surplus capacity capable of development.

These two cities have also, within easy transmission distance, the large water power at Silver Falls on the Kaministiquia River, at which point about 20,000 h.-p. minimum can be developed under a 310 foot head.

Intake to Kaministiquia Power Company's Development.

Concerning th Nipigon, th 'argest of the Lake Superior tributaries, the following facts may be set forth:

The river proper . 40 miles long and drops 255 feet in this distance.

At the head of the river is Lake Nipigon, with 1,500 square miles of water surface, receiving the run-off from about 9,500 square miles of drainage area. The effect of this immense central storage basin is to produce a flow regimen almost comparable to that of the St. Lawrence, and to make the river an ideal one for the development of power.

The Nipigon basin contains one of the finest pulp-wood areas in the world.

It also contains immense bodies of magnetic iron which would doubtless yield to treatment in the electric furnace.

Silver Falls, Kaministiquia River.

The Nipigon water powers are within easy transmission distance of Port Arthur and Fort William, and while these cities have 50,000 h.-p. hydraulic capacity available within a radius of 25 miles, the time will undoubtedly come when they will need Nipigon power.

In 40 miles of river there is 100,000 h.-p. in the main, capable of easy development, and in this fact, together with the great natural resources of its basin, and the certainty of industrial expansion at the head of the Great Lakes, the Nipigon basin affords a range of commercial opportunities which can hardly be duplicated on the Continent to-day.

THE WINNIPEG RIVER AND ITS TRIBUTARIES

THE drainage system of Rainy River District is wholly tributary to the Hudson Sea by way of Lake Winnipeg, and forms part of the great basin of the Nelson River. The rivers in this district are as a general rule large and full flowing, but with low natural heads. This disadvantage from a power standpoint is in a measure offset by the splendid storage facilities offered by Rainy Lake, Lake of the Woods and Lac Seul, which, together with a countless number of smaller lakes, constitute the outstanding topographical feature of the Rainy River district. The hydrography of this territory has been studied to a limited extent only, but such information as is available indicates that the total potentiality of the various rivers is not less than 250,000 h.-p. Of this total about 22,000 h.-p. is now in use, leaving 228,000 h.-p. undeveloped. The largest development in this district is at Fort Frances, where Koochiching Falls, on the Rainy River, has been

Power Development of Minnesota and Ontario Company, Fort Frances, Ontario.

developed by the Minnesota & Ontario Power Company. This is an international river, and half of the power is supposed to be developed on each side, the present installation on the Cana[illegible] side being 15,000 h.-p., practically all of which is used for the manufacture of pulp [illegible] paper.

At K[illegible] [illegible]ing flour milling industry has grown out of the partial utilization of the large w[illegible] power at the outlet of the Lake of the Woods. At this point the Town of Kenora has developed about 2,500 h.-p., and has 2,000 h.-p. of surplus capacity still available. The bulk of this plant's product is used for flour milling, and lighting load. At this point also the Lake of the Woods Milling Company has large flour mills using about 4,000 h.-p. of hydraulic and electric power.

At Dryden, on the Wabigoon River, the Dryden Timber & Power Company has a 2,000 h.-p. plant installed for the manufacture of pulp and wood products.

The two principal sources of power for the district are the Winnipeg and English Rivers. In addition to a large natural minimum flow, the hydraulic value of these rivers lies in the fact that the extensive lake areas in their basins provide facilities for practically doubling the low water flow. Under such conditions White Dog Falls, on the Winnipeg River, would alone be capable of producing 75,000 h.-p., and at each of several sites on the English River power could be developed in blocks of 20,000 to 40,000 h.-p. More particularly in the case of the English, the natural resources of the territory drained by these rivers are rather meagre, but the completion of the Transcontinental Railway will tend to hasten the utilization of their great store of energy.

RIVERS FLOWING INTO JAMES BAY

A VERY small amount of credible information is at present available with regard to the rivers of the James Bay slope, such detailed information as is available being confined to one or two rivers on which power has already been developed or is in course of development. The Conservation Commission in its report on the "Water Powers of Canada" quotes figures, compiled by Mr. L. V. Rorke, formerly Inspector of Surveys for Ontario. Mr. Rorke estimates the minimum power capacity of the James Bay Rivers to be 665,000 h.-p. under natural conditions. With controlled storage he estimates their capacity to be about 1,700,000 h.-p. This latter figure is based upon an assumption as to the volume of controlled run-off, which may not obtain in many instances, but if the newly acquired District of Patricia is included, a capacity of 1,500,000 h.-p. may, with a fair degree of certainty, be assumed physically capable of development.

Power development in this territory is now limited to the two plants of the Northern Canada Light & Power Company on the Mattagami River. These plants supply about 3,500 h.-p. to the mines and towns of the Porcupine mining district, and have about 7,000 h.-p. capacity available.

The Abitibi Pulp & Paper Company has a 19,500 h.-p. plant at Iroquois Falls, on the Abitibi River, which will shortly be in commercial operation. This Company has secured

General View of Abitibi Pulp and Paper Company's Plant, Iroquois Falls, Ontario.

leasehold rights to water powers aggregating 50,000 h.-p. capacity, with regulated flow from the available storage in Abitibi Lake.

As in the case of the Winnipeg and English Rivers, the completion of the Transcontinental Railway will give an impetus to hydraulic development on the James Bay rivers, particularly as regards the larger water powers to the north of the railway, these having heretofore been quite inaccessible from a commercial standpoint.

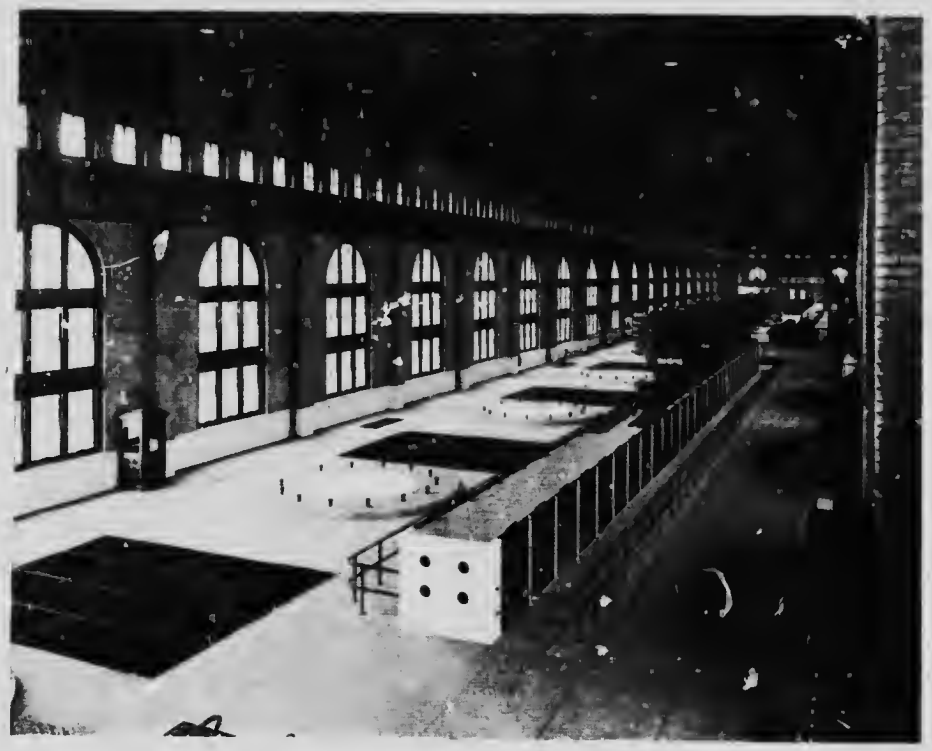
INTERNATIONAL RIVERS OF ONTARIO

IN the water powers of her International rivers the Province of Ontario possesses a natural asset of the first magnitude, and one which is destined to have a great and beneficent influence on her future prosperity. The greatest of these is Niagara, until recently famous only as a scenic spectacle, but inherently a vast and inexhaustible storehouse of energy, which even now yields much, but which in the future must yield more and more of its bounty in response to the increasing pressure of economic necessity.

While aesthetic opposition to the commercial exploitation of Niagara is more or less of a sentimental factor, which must fade in the face of more pressing issues, there are certain practical limitations which must always obtain, arising principally out of the fact that the proper development of power involves the diversion of water from the natural channel of the river above the main cataract and the upper rapids.

Power House, Electrical Development Company, Niagara Falls, Ontario.

Niagara Falls. Showing Development on Canadian Side.



Power House of Canadian-Niagara Power Company.

Power is now developed on the Canadian side of Niagara, under franchises granted by the Province of Ontario, through the Queen Victoria Niagara Falls Park Commission. Under these franchises a total of 405,000 h.-p. is to be developed, 100,000 h.-p. by the Canadian Niagara Power Company, 125,000 h.-p. by the Electrical Development Company and 180,000 h.-p. by the Ontario Power Company. The Canadian Niagara Power Company began to deliver power in 1905, and the importance of cheap hydro-electric power as an industrial factor is impressively demonstrated by the fact that, in the space of nine years, the three above mentioned companies have 369,000 h.-p. either in actual use on maximum load, or in course of installation to meet immediate requirements. The Ontario market is served principally by the Electrical Development Company and the Ontario Power Company, the former serving the City of Toronto, while the latter serves an extensive territory in Western Ontario, through the medium of the transmission system of the Hydro-Electric Power Commission.

Although the water powers on the Welland Canal are not international, they are mentioned in connection with the boundary streams through the fact that the water which creates them is drawn from Lake Erie.

At the present time power is developed on the old Welland Canal to the extent of about 12,000 h.-p., and the important industries in connection with which they are used embracing the manufacture of pulp and paper, tools, cloth, carbide, rubber, etc., contribute largely to the prosperity of the City of St. Catharines and the Towns of Merritton and Thorold.

The most important power development connected with the canal system is that of the Dominion Power & Transmission Company. This company draws water from the summit level of the canal and carries it over the Niagara escarpement at Decew Falls, where power is developed under a net head of about 265 feet, 57,000 h.-p. of capacity being now in active use. Through the medium of 213 miles of 10,000 to 40,000 volt transmission line power is supplied for the operation of an extensive system of radial and street railways, and for the lighting and industrial requirements of a number of municipalities in the Niagara Peninsula, as well as to Brantford, Burlington and Oakville. The present commercial prominence of the City of Hamilton is due in a large measure to the fact that power developed by the Dominion Power & Transmission Company was made available at rates sufficiently attractive to encourage the establishment of industries.

The normal difference in level between Lake Superior and Lake Huron is about 20 feet, of which, about 18 feet, is concentrated at the St. Mary's Rapids. The minimum flow at this point will produce 90,000 h.-p. under an 18 foot head, half of which capacity belongs to Ontario. For some years past this power has been partially utilized both in Canada and the United States, about 17,000 h.-p. being now developed on the Canadian side by the

Power House of Electrical Development Company, Niagara Falls, Interior View.

Algoma Steel Corporation and its allied industries. This company has under consideration the remodelling of its hydraulic plant and an increase in capacity to 30,000 h.-p.

So far as the Province of Ontario is concerned, the power possibilities of the St. Lawrence River are limited to that portion lying between Lake Ontario and Lake St. Francis. The normal fall in this portion of the river is about 88 feet, and possibly 70 feet of this could be effectively utilized for power development. On this basis the aggregate effective capacity, under normal low water conditions, would be about 1,000,000 h.-p., of which 500,000 h.-p. would be available for use in Ontario.

Sault Ste. Marie Pulp and Paper Company.

At the present time there is no development in this reach of the main river, present development being confined to various small water powers created along the shores by the St. Lawrence canal system. Hydraulic plants connected with the canals are operating at Cardinal, Iroquois, Morrisburg, Milles Roches and Cornwall, their aggregate capacity being about 5,800 h.-p. The bulk of this power is used locally, the two largest plants supplying the Town of Cornwall.

As regards the feasibility of developing the international water powers of the St. Lawrence on a large scale, it is to be understood that such development would require the consent or co-operation of the United States. Furthermore, the construction cost of permanent works for the proper development of these powers will be abnormally high, and a market demand very largely in excess of that now existing will be necessary to place any such development scheme upon a feasible commercial basis.

SUMMARY OF UNDEVELOPED AND DEVELOPED WATER POWERS IN ONTARIO

TAKING the various figures for power capacity mentioned above and adding thereto the estimated capacity of a number of smaller rivers not specifically mentioned, the following approximate summation is derived for the total amount of power capable of development in the Province of Ontario:

Ottawa River and Tributaries	688,000 h.-p.
Great Lakes Tributaries	446,000 "
Hudson Bay Slope	250,000 "
James Bay Slope	1,500,000 "
International Boundary Rivers	2,045,000 "
Total Potentiality	4,929,000 h.-p.

Similarly the totals, for the developed power, may be summarized as follows:

Ottawa River and Tributaries	71,000 h.-p.
Great Lakes Tributaries	137,000 "
Hudson Bay Slope	22,000 "
James Bay Slope	70,000 "
International Boundary Rivers	462,000 "
Total Developed Power	702,000 h.-p.

Of this latter total, about 574,000 h.-p. is electric energy sold for light and power, about 69,000 h.-p. is used for pulp and paper manufacture, and about 59,000 h.-p. is used for the most part in the form of hydraulic power directly applied. According to the above figures, the developed capacity of the Ontario water powers is about one third greater than the capacity developed in Quebec. Ontario's advantage is mainly derived from the capacity developed for purposes of transmission, as is indicated by the fact that in Ontario 2,200 miles of 10,000 to 110,000 volt transmission line is in operation at the present time. The result of this widespread transmission system, and extensions to the same now under construction, is to make hydro-electric power available to all the cities and large towns in Ontario, and to a rapidly increasing number of smaller towns, at prices ranging from $15.00 to $40.00 per horse-power per annum.

ONTARIO HYDRO-ELECTRIC POWER COMMISSION

WITH the history of hydraulic and hydro-electric development, in Ontario, must always be associated the epoch making operations of the Hydro-Electric Power Commission in connection with the development and transmission of power, under joint governmental and municipal auspices.

When, about the year 1900, definite schemes for the development of Niagara power began to take form, public sentiment became awakened through fear that the only source of hydraulic power available to the south-western peninsula of Ontario might be exploited wholly for the benefit of private interest, and that the people of this part of the Province might be laid under the yoke of a power monopoly.

Public opinion in connection with this matter rapidly gathered strength, and the first result of the agitation was the report of the Ontario Power Commission, issued March 28th, 1906. This Commission was created under the terms of the Municipal Power Works Act of 1903, and its duty was broadly to report upon the feasibility of the co-operative development and transmission of Niagara power by and for a group of seven cities and towns in Western Ontario. The report of this Commission opened the eyes of the public to the commercial value of Niagara as a source of power for this portion of the Province, and rapidly accelerated the development of public sentiment. Partly in deference to public opinion, but largely upon its own initiative, the then recently formed Whitney Government appointed a new commission, called the Hydro-Electric Power Commission, to investigate power conditions generally throughout the Province, under direct governmental auspices. The result of these investigations were published in the form of five valuable reports in which were set forth the locations and estimated capacities of the Province's water powers, and also the estimated cost of various power development and transmission schemes, whereby the industrial centres of the Province might be cheaply and adequately served.

Among other important results, the investigations of this Commission amply confirmed the findings of the Ontario Power Commission as to the commercial feasibility of transmitting power from Niagara to the municipalities of south-western Ontario. In view of this fact, the Provincial Government felt itself justified in making provision for the practical realization of these possibilities, and the Hydro-Electric Power Commission, of Ontario, was formally created by statute in May, 1906. The powers vested in the Commission under the Power Act were enlarged and amplified in 1907, and it is under the terms of the latter Act and some subsequent amendments, that the Commission is operating at the present time, and by virtue of which wonderful and far-reaching results have been achieved.

As previously explained, it was the public need of the manufacturing centres of Western Ontario, as related to the potentiality of Niagara, that led to the creation of the Commission, so that the efforts of the Commission were naturally first applied in this direction. It is not possible within the space available to do full justice to the history of the Commission's subsequent activities, but a few of the more important facts in connection therewith may be briefly summarized.

The power companies at Niagara Falls were asked to submit tender prices for the supply of power to the Commission. The Ontario Power Company submitted the lowest price, and, after protracted negotiations, a 30 year contract was entered into whereby the Commission was to be supplied with 100,000 h.-p. of 12,000 volt power at a minimum price of $9.00 per horse-power per annum.

On January, 1908, by-laws were submitted in 13 municipalities for the purpose of raising the sums of money necessary to cover the cost of locally distributing the power to be purchased from the Commission. In the face of bitter, and in many cases unfair opposition, the by-laws carried by large majorities in 12 of the 13 municipalities. The defeated by-law was also subsequently carried.

After the passing of the by-laws the Commission entered into a contract with the municipalities covering the supply of an aggregate of 25,135 h.-p., at prices ranging from $18.10 to $29.50 per h.-p. per annum, based upon the actual estimated cost of service.

Following the execution of this contract, surveys were completed and tenders called for all classes of construction and equipment necessary to complete the Niagara transmission system, and early in the fall of 1909 all construction work was under way.

Work on the erection of the transmission line began on July 22, 1909, and by the middle of December, 1910, 280 miles of 110,000 volt line had been completed, involving the erection of 3,040 steel towers, 12,896 insulators and 1812 miles of wire. The telephone and relay line in connection with the system was also completed, and involved the building of 296 miles of line, including the erection of 12,368 poles and 1,548 miles of copper wire. During this period also, 11 sub-stations were built and equipment installed.

Four years later, on December 31st, 1914, the Commission had built and in operation 433 miles of 110,000 volt line, 800 miles of 2,300 to 46,000 volt lines, 1,500 miles of telephone line and 63 stations.

The above figures include the construction of the Severn System, the Port Arthur System, and the St. Lawrence and the Wasdell's Falls System, all of which have been developed since the completion of the original Niagara System in December, 1910.

In place of the 13 municipalities supplied in the early part of 1911, the Commission is now supplying 73, and in place of a load of about 1,000 h.-p. in December, 1910, the average load on the Niagara System alone is now about 63,500 h.-p.

The number of consumers connected to the whole Hydro System on December 31st, 1912, was 34,967. On December 31st, 1914, the number of consumers was 96,744, an increase of nearly 200% in two years.

On October 31st, 1912, the Commission's total investment was $4,579,830. On October 31st, 1914, this investment had increased to $10,130,049, or 250% in two years.

Up to December 31st, 1914, the Municipalities taking power from the Commission had themselves invested $14,303,857, in local distribution plants, making a combined total investment of $24,433,906, on the part of the Commission and its customers inside of six years.

It is to be noted in connection with this investment that it is in no shape or form a charge on the general tax payer, either as regards the Province or the Municipality. Every dollar

of the carrying charges, on the investment of the Commission and the Municipalities, comes out of the pocket of the light and power consumers, and the price paid by the individual consumer is so regulated as to provide sufficient income to completely cover all annual interest and sinking fund charges on the combined Commission and Municipal investment, as well as all depreciation, maintenance, operation and administration charges. This Statutory requirement is also retroactive, in that all surplus revenue, after meeting the above charges, must be applied to extension of plant, to depreciation reserve, or to reduction of rates, and must under no circumstances be used to reduce the general tax rate of any municipality.

As related to the present financial standing of the Hydro-Electric enterprise, the following statistical summary, from the 1914 report of the Commission is of interest. These figures are derived from the annual audit of the books of the Municipalities:

	Dec. 31st, 1912	Dec. 31st, 1913
Number of Municipalities included in report	28	45
Operating and Maintenance expenses	$1,086,135.00	$1,511,048.00
Debenture charges and interest	291,033.00	479,995.00
Total annual expense	1,377,168.00	1,991,043.00
Total Revenue	1,617,674.00	2,611,918.00
Surplus for Year	240,506.00	620,875.00
Depreciation Charge	179,847.00	230,480.00
Surplus Less Depreciation Charge	60,659.00	390,395.00
Total Plant Value	6,349,711.00	9,196,483.00
Net Debenture Debt and Overdraft	5,882,156.00	8,353,819.00
Accumulated Surplus Invested in Plant Extension	.....	861,381.00
Accumulated Depreciation Reserve	.....	410,327.00
Surplus from Operation	.....	451,054.00
Approximate Number of Consumers Light	33,568	63,157
" " Power	1,399	2,532
Total	34,967	65,689

These figures are an impressive answer to the bitter criticism to which the enterprise was subjected during its formative period, and the firm basis upon which it is now established would seem to preclude the possibility of ultimate failure.

As to the future of the Commission, its aims are well expressed by its Chairman, Sir Adam Beck, in an address delivered before The Conservation Commission of Canada, at Ottawa, in January, 1910.

"If the construction project now nearing completion answers, as I have every confidence it will, the expectations formed of it, the future of the Commission will be devoted to the completion of the work begun. The Government is not a Trustee for the interests of any particular group of municipalities, or any particular part of the people, to the exclusion of the rest. Its obligations are the same to all the people and all their municipal institutions.

SINCE GOING TO PRESS THE TABLE ON PAGE 38 OF THE PAMPHLET ON "THE WATER POWERS OF ONTARIO" HAS BEEN BROUGHT UP TO DATE AND IS REVISED AS FOLLOWS:—

	Dec. 31st, 1912	Dec. 31st, 1913	Dec. 31st, 1914
Number of Municipalities included in report	28	45	69
Operating and Maintenance expenses	$1,086,135.00	$1,516,613.00	$2,012,754.00
Debenture charges and interest	291,033.00	525,054.00	661,949.00
Total annual expense	1,377,168.00	2,041,667.00	2,674,703.00
Total Revenue	1,617,674.00	2,617,439.00	3,433,936.00
Surplus for Year	240,506.00	575,771.00	759,233.00
Depreciation Charge	124,992.00	262,675.00	357,883.00
Surplus Less Depreciation Charge	115,514.00	313,096.00	401,350.00
Total Plant Value	6,349,711.00	11,977,175.00	15,249,203.00
Net Debenture Debt and Overdraft	5,882,156.00	10,468,351.00	12,702,690.00
Accumulated Surplus Invested in Plant Extension	284,211.00	859,983.00	1,601,167.00
Accumulated Depreciation Reserve	240,229.00	502,904.00	850,618.00
Surplus from Operation	43,982.00	357,079.00	750,549.00
Approximate Number of Consumers Light	33,568	63,157	93,179
" " " Power	1,399	2,532	3,565
TOTAL	34,967	65,689	96,744

In prosecuting this work, however, just as it will not be deterred by slander, neither will it be hurried by impatient clamor. It will proceed cautiously and prudently step by step, testing and proving its way, that its progress may be real and enduring. An abundant supply of motive power is to the manufacturing arts what blood is to the human body. It is their very life. And upon the progress of the manufacturing arts depends the future of this country in the international markets of the world. Supremacy in these arts gives employment and prosperity to the people at home, influence and power to the country abroad, and in combination with the unbounded granaries of the West, it assures to the Dominion a beneficent as well as an honorable place in the civilization of that, as yet unshaped, Imperial future to which we all look forward. Nor would I forget the patient toilers of the land. Back of, and sustaining the manufacturing arts, are the great agricultural classes—the keepers of the granaries of Empire—the ultimate source and foundation of moral and political strength, as well as of material greatness. To raise the scale, by multiplying and cheapening the comforts of life for these great classes, is one of the prime objects of the Commission. That it will ultimately be accomplished I have no manner of doubt."

"This is the task to which I have set my hand. This is the task to which I shall devote my public life. It is no ignoble work. I am not ashamed of it, and I am well assured that the villification of the present will give place to the vindication of the future, and that its consummation will contribute to national strength and national greatness."

ADMINISTRATION OF WATER POWERS IN ONTARIO

BY virtue of an act respecting Water Powers, passed by the Legislature of Ontario in 1898, and of the Regulations made thereunder, water powers, the property of the Crown, in Ontario may now be leased on certain conditions. The administration of the law is in the hands of the Minister of Lands, Forests and Mines. Following is a synopsis of the regulations:—

The applicant for a water privilege is required to file in the Department of Lands, Forests and Mines, plan and field notes by Ontario Land Surveyor, showing the water power and the land required in connection with the same; also report by a competent engineer, satisfactory to the Minister, giving the height of the fall, estimated capacity of same in the natural condition or at the average low stage of water, the height of the dam if any, which it is proposed to construct, and the consequent increase in the level of the waters. The applicant is required to file the plan by which he proposes to develop the water privilege, also to state the estimated cost of development, and the form in which the power is to be used or transmitted, that is whether by direct energy, electricity, compressed air, etc. He must indicate the lands to be overflowed, or otherwise affected, and the nature and location of the plant, manufactory or other industrial establishment in connection with which he proposes to use the power; and also furnish satisfactory proof that the

water privilege is required for bona-fide industrial or mechanical purposes, or to supply an anticipated or actual demand for power within transmission distance.

If required by the Minister, the applicant shall likewise furnish all measurements, plans, applications, etc., as may be required, and the same may be submitted to the Hydro-Electric Power Commission of Ontario for its approval, in which case the works shall not be proceeded with until such approval is given. The applicant must also submit proof of his financial standing and ability and intention to develop the water privilege.

Before the lease is granted the applicant must deposit, with the Treasurer of the Province, a sum of money, say $500.00 or upwards, proportioned to the capacity of the water power, as guarantee that the development conditions will be duly carried out, this sum to be returned to the lessee upon fulfillment of the same, otherwise to be forfeited to the Crown.

An annual rental is charged, based upon the number of horse-power to be developed. The term of the lease is twenty years, the lessee having the right of renewal for two further and successive terms of ten years each, upon such terms and conditions as may be agreed upon or fixed by the Minister.

Navigation, which is under the control of the Government of Canada, must not be interfered with, and if the stream is used for log-driving purposes, the lessee must provide facilities for the safe and convenient passage of logs and timber.

The lease will require the holder to develop and use, within a given period, a specific quantity of horse-power. If such quantity is less than the full capacity of the privilege, upon report of the Hydro-Electric Power Commission, the lessee may be required to develop the privilege to its full capacity, or to such other extent as may be requisite.

If there is a surplus of water or power not required by the lessee for his business, plant or manufactory, he shall supply other parties desirous of power, and failing agreement as to terms, the matter may be submitted to the Hydro-Electric Power Commission, and upon their report the Lieutenant-Governor in Council may fix and determine the rates and conditions upon which the power shall be supplied.

Any engineer appointed by the Hydro-Electric Power Commission shall have free access to all parts of the works, and all books, plans or records, etc., for the purpose of ascertaining whether the works are being constructed according to the plans approved by the Commission, and also to compute the quantity of power developed.

During the continuance of the lease the lessee shall maintain the works in good repair and condition, and at the expiry of the lease the water privilege shall revert to the Crown, but where permanent buildings or structures have been made, the Lieutenant-Governor in Council may, on report of the Hydro-Electric Power Commission, compensate the lessee therefor.

Where a water privilege is required by a municipality for the purpose of supplying water power, light or heat to the inhabitants, the Minister may issue a lease upon such special terms and conditions as are recommended by the Hydro-Electric Power Commission, and on such rental as he may deem proper.

Water power leases are subject to general regulations made or to be made by the Lieutenant-Governor in Council, and may be cancelled for non-compliance with any of

their terms or conditions, or upon neglect by the lessee for the space of one year effectually to produce power from the water privilege.

The Hydro-Electric Power Commission has the right under the Statutes of Ontario, to acquire water powers and works by purchase, lease, or otherwise, or without the consent of the owner.

The foregoing regulations are not applicable to water privileges which, in their natural condition, at the average low stage of water, have not a greater capacity than 150 horse-power.

All applications for water powers should be made to the Minister of Lands, Forests and Mines, Toronto, Ontario.

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For further information regarding water powers in Canada, application should be made direct to the following administrative officers of the Dominion and the various Provincial Governments:

Province of British Columbia: The Comptroller of Water Rights, Victoria, B.C.

Provinces of Manitoba, Saskatchewan and Alberta: The Superintendent of the Dominion Water Power Branch, Ottawa, Ont.

Province of Ontario: The Deputy Minister of Lands, Forests and Mines, Toronto, Ont, also, to the Secretary of the Hydro-Electric Power Commission of Ontario, Toronto, Ont.

Province of Quebec: The Chief Engineer, Hydraulic Service, Department of Lands and Forests, Quebec, Que.

Province of New Brunswick: Surveyor-General of New Brunswick, Fredericton, N.B.

Province of Nova Scotia: The Secretary of the Nova Scotia Water Power Commission, Halifax, N.S.