THE ROSS REPORT ON HYDRO-ELECTRIC POWER

Gives Musquash River Power Available and Cost of Distributing Power at St. John—Works Out Cost to Consumer at 7.99 Cents—Distribution System Would Cost $1,594,432—Skeptical Regarding Promised Horse Power in Dry Spell.

REPORT OF POWER AVAILABLE AT MUSQUASH.
Cost Delivered to Customers in St. John.
Montreal, 285 St. James Street,
February 10th, 1922.

His Worship Mayor Schofield,
Saint John, N. B.

Dear Sir,—

Hereto attached find report covering the Power available at the Musquash, and the cost delivered to customers in Saint John.

The outstanding features of this report being as follows:

(1) On the basis of the gauging records the power available at Saint John during a year of minimum precipitation will be ..... 17,000,000 k.w.h.

(2) As the gaugings show such extraordinary results when compared with the precipitation they cannot be accepted with safety.

(3) On the basis of the precipitation records, the power available at Saint John during the year of minimum precipitation will be not in excess of ..... 9,000,000 k.w.h.

(4) As the yearly Operating and Fixed Charges which are a constant when divided by the k.w.h., the latter is indeterminable owing to the doubtful output

(5) The requirements of the present customers of the Company for Light and Power and Street Lights total ..... 6,250,000 k.w.h.

(6) The total requirements of the Company for 1920 totalled ..... 12,113,490 k.w.h.

(7) The Capital Cost of a new distribution plant and steam standby station to cover Light and Power and Street Lighting is $1,594,432

(8) The cost per kilowatt hour to the customer from a new civic distribution plant covering all customers of the Power Company will be ..... 7.99c. per k.w.h

(9) The high cost of Light at St. John as compared with Brantford, Hamilton, London, Windsor, is accounted for by the high cost of construction at present, and the necessity for a steam standby, but above all the restricted use per customer in Saint John. On the same basis as above cities in these regards the cost per k.w.h. at Saint John would be:

Basis of Brantford	3.50c. per k.w.h.
Basis of Hamilton	3.90c. per k.w.h.
Basis of London	2.70c. per k.w.h.
Basis of Windsor	3.50c. per k.w.h.
On report basis of St. John	7.99c. per k.w.h.
Actual for 1920 basis of St. John	8.55c. per k.w.h.

(10) The cost of Power compared with Niagara is too high and the amount too restricted to permit obtaining motor loads common in Ontario, thus utilizing the distributing system for many hours per day instead of a few hours at night as at present, with consequent reduction in cost per k.w.h. for all services.

The whole respectfully submitted

R. A. R.

SECTION 1.

Power on Musquash River—What Power is Certainly Available and at What Price.

Power Situation at Saint John.

A study of the situation in the City of Saint John with regard to power indicates the presence of four interested parties:

1st. The New Brunswick Electric Power Commission (hereafter called the Commission) who having developed a power on the Musquash River now offers the City of Saint John the output of that plant delivered on the outskirts of the Municipality.

2nd. The Municipality of Saint John (hereinafter called the City) who are considering the offer of the Commission in the best interests of the citizens.

3rd. The New Brunswick Power Company (hereinafter called the Company), the present distributors of power, light, street railway, gas and street lighting in the City of Saint John.

4th. The citizens of Saint John who are at present consumers of Light and Power (hereinafter called the Customers).

The problem is to bring the parties into such relation that the Customers will receive the most benefit.

There are four positions which might be adopted by the City in this regard:

1st. Not to accept the Commission's offer, and to leave matters as they stand in the hands of the Company.

2nd. To accept the Commission's offer, and resell to the Company under an undertaking by the latter to reduce rates.

3rd. Accept the Commission's offer, and purchase the Company's distributing plant by agreement or arbitration.

4th. To accept the Commission's offer, and construct a new system of distribution operated by the City, presumably in competition with the Company.

To make a choice among these alternatives involves questions, not only of policy and of business, but also technical matters, for it is evident that when contemplating the purchase of power it must be clear just what amount of power is certainly available; the price to be paid; and also as to what it would cost to distribute the power throughout the City.

No decision can be reached therefore without technical information covering the following points:

(a) What power is certainly available from the Commission, and at what price.

(b) What will be the cost of distributing this power to light and power customers.

These two points and these only are discussed in this report which gives no consideration to questions of business or policy, but submits such data as should enable the administration of the City to decide these matters for themselves.

Technical Terms Used.

Drainage Area.—That area of country whose flow is tributary to the stream under consideration usually expressed in square miles.

Precipitation.—The fall of rain and snow expressed as depth in inches per year on an area, recorded by the Meteorological office of the Dominion Government at rainfall stations scattered throughout the country.

Evaporation.—A general designation for all losses of precipitation, including evaporation, seepage, leakage, plant necessities, etc., which appear on all drainage areas, measured usually in inches of depth over the area.

Run-Off.—The amount of water available for power purposes after allowance has been made for evaporation expressed as inches of precipitation, minus inches of evaporation—inches of Run-off. Also expressed in convertible terms as cubic feet per second of water flow, or in total cubic feet of water available per square mile of area, or as a percentage of precipitation.

Gauging.—Actual measurements by meter from day to day of the run-off by the Water Power Branch of the Dominion Government, expressed in second feet of flow or depth in inches over the drainage area.

Second Feet.—As applied to Run-off is an abbreviation for flow of water in cubic feet per second (c.f.s.) and is expressed as c.f.s. per square mile usually.

Mile Foot.—The number of cubic feet of water which can be accumulated on an area of one square mile if the depth is one foot.

Static Head.—The difference in level measured in feet between the head-water and tail-water of a power plant.

Kilowatt Hour, K.W.H.—The work done by a kilowat of power operating for one hour—1 1-4 horsepower hours.

Musquash Development.

The power to be supplied Saint John is to be obtained from a development on the Musquash river covering both east and west branches, the outstanding features of which are as per table:

Table No. 1.

	East Branch	West Branch	Total
Tributary drainage area in square miles	72	76	148
Static head on wheels	98	117	Av. 103
Capacity of wheels K.V.A.	2—3000	1—3900	9700

Under the above 100' head and with a generator efficiency averaging 90 per cent and a wheel efficiency at 90 per cent, which seems fair when considering the fact that on the Saint John demands the load factor of the operating machines will be for many hours 33 per cent or less, the number of cubic feet of water at the wheels necessary to generate one k.w.h. is 570 c.f.

The Commission have in contemplation the supply of 21,000,000 k. w. h. at St. John. Assuming 10% loss in switching, transmission and transforming the generated output at the Musquash would be 23,333,333 k. w. h. Total k. w. h. generated per square mile will therefore be 157,000. To supply the necessary wheel water for this amount of power would require a depth per square mile of run-off gathered at the wheels of 3.36 feet or 39.13 inches.

Steam Gaugings.

In this district there are three contiguous drainage areas tributary to the Magaguadavic, Lepreau and Musquash rivers, upon which gaugings have been made to determine the available flow,—the general characteristics of these areas being as per Table "2."

Table No. 2.

Run-Off of Certain Streams in New Brunswick for Years Ending September 30th.

		Magaguadavic.	Lepreau.	West Musquash.
	Drainage area to gauge square miles	674	90	76
1919	Mean run-off; second feet	1257	299	.....
	Run-off; second feet per square mile	3.19	3.32	.....
	Run-off; depth in inches	29.78	45.30	.....
1920	Mean run-off; second feet	1422	309	.....
	Run-off; second feet per square mile	2.51	3.43	.....
	Run-off; depth in inches	34.05	46.59	.....
1921	Mean run-off; second feet	1147	248	187
	Run-off; second feet per square mile	2.00	2.75	2.46
	Run-off; depth in inches	27.18	37.55	33.60
	Average depth run-off for period	30.3"	43.1	.....

It will be noted that the West Musquash has only been gauged for a year and the East Musquash practically not at all. The item which attracts immediate attention in comparing these areas is the high run-off 43.1 inches from Lepreau as compared with 30.3 inches on the Magaguadavic. When it is considered that these three areas are all subjected to the same climatic conditions including rain-fall, it is difficult to account for this difference even when allowance is made for the increased size of the Magaguadavic watershed and its reported different character. Further, it will be noted that even the Magaguadavic has a high run-off as compared with similar streams as will be shown later. It should be stated also that the records of Lepreau for the year 1919 only were used to design the Musquash Plant for which no record then existed, and that the latter is now showing a considerable reduction on gaugings being taken.

In this and following tables it may be stated that all the figures of gaugings, etc., quoted have been obtained from the Water Power Branch of the Dominion Government, and are therefore authentic.

In an attempt to check these results, the tables of Nos. 3 and 4 have been developed showing the run-off gaugings on occasional days and also by months for a year, affording a direct comparison between those on the West Musquash and Lepreau.

An examination of these sheets indicate a curious change in the characteristics of the West Musquash and Lepreau in that almost invariably in both tables the West Musquash has a higher run-off per square mile than the Lepreau on low readings. Immediately, however, the run-off is in excess of about 4 c.f.s. The Lepreau becomes the higher.

As is well known it is not acceptable to compare month by month the flow of two rivers even on adjacent watersheds with the expectation of finding them identical. But there seems such a flavor of reversal of form in those records that the question might well be asked whether the rating curves of the Lepreau may not be inaccurate on the higher readings. If this be found not to be the case, the suggestion is made that there might possibly be a slop over at high river levels from the West Musquash to the Lepreau possibly by an underground fissure or boulder and gravel bed leak.

Attention is called to this because if there should be found to be a serious shortage on the West Musquash, some such trouble may exist; and it is quite possible that it will be accentuated when the original river levels are changed through the filling of reservoirs, involving a higher head upon leaks if any in the district covered by the storage basins.

Table "3."

Comparison Between Run-Off of Musquash and Lepreau Rivers By individual Measurements.

Date. 1920	Lepreau River Gauge Reading or measurement	Lepreau River Second-feet per Square Mile	West Musquash River Gauge Reading or measurement	West Musquash River Second feet per Square Mile	East Musquash River Gauge Reading or measurement	East Musquash River Second-feet per Square Mile
July 26	0.61	G	0.72	M	..	
July 27	0.50	G	0.60	G	0.71	M
July 28	0.46	M	0.53	G	....	
August 4	0.31	G	0.40	G	0.42	M
August 5	0.31	G	0.38	M	0.38	G
August 24	0.61	G	0.71	M	0.81	G
August 25	0.56	G	0.78	G	0.85	M
Nov. 10	5.28	G	4.38	M	....	..
Dec. 21	6.67	G	4.05	M	....	..
Dec. 22	4.89	G	3.95	G	5.10	M
Dec. 23	3.85	M	3.84	G	....	..
1921						
Feb. 3-4	1.20	M	1.05	M	1.47	M
March 17-18	7.12	M	6.26	M	....	..
June 21	0.24	G	0.23	M	....	..
June 29	0.16	M	0.24	G	....	..
August 26	0.12	G	0.13	M	....	..
August 27	0.13	M	0.13	G	....	..

Note.—"M" denotes discharge obtained by current meters measurement. "G" denotes discharge as taken from rating curve for observed gauge height.

Table "4"

Comparison Between Run-Off of Musquash and Lepreau.

The following table shows measured run-off in inches per month for period (or which records for both streams are available.)

Month	Lepreau	West Musquash	East Musquash
1920			
August	0.68	0.76	0.79
September	1.21	2.09	1.99
1920-21			
October	2.26	2.96	2.61
November	4.89	4.34	
December	7.36	6.75	
January	3.89	3.93	
February	1.42	1.09 Est	
March	8.54	7.49 Est	
April	6.64	5.50	
May	1.76	1.27	
June	0.82	0.29	
July	0.07	0.16	
August	0.12	0.28	
September	0.28	0.28	
	37.55 12months	33.60-12 months	
1921-22			
October	0.77		
November	3.77		

In an endeavor to locate the reason for the high run-off recorded in this district, a visit was paid to Ottawa to the office of the Water Power Branch of the Dominion Government; and Mr. K. H. Smith, their representative in the Maritime Provinces, was good enough to come to Montreal and go into the question.

He seems confident of his records and has furnished a report (copy of which is attached hereto as an appendix) from which all the figures herein are derived.

As the question of reliability as between run-off records and precipitation records has been discussed very fully in his report, it is only just to him that this should be given in full. (See appendix).

Precipitation Records

As the percentage run-offs indicated by gaugings in this district when compared with hundreds of others reasonably comparable and reliable this never been reached before, the question of precipitation must be brought into the discussion.

It must be remembered that up to a few years ago, the only information engineers had as to stream run-off for use in the development of water powers, was obtained from the records of precipitation taken by the Dominion Government at various stations throughout the Country; and while it is recognized that accurate and seasoned gauge readings are more acceptable, under the extraordinary conditions shown in these gaugings records, actually taken for only a short period, a comparison at least must be made between these two sources of information.

In Table "5" the precipitation records in the district for the years 1920-20-21 are given, from which it will be noted that those at Saint John have been exceeded for fifty-nine years; also that record is the highest in the district, and if applied to the drainage areas in question will undoubtedly allow a higher precipitation than the district actually received, those from the surrounding stations being less, and generally very much less. Further, this record being kept at the headquarters of the Meteorological Bureau for this district under the eye of the director, and for a period of fifty-nine years, may well be considered a model.

Table No. 5.

Rainfall Records at Certain Places in New Brunswick for Years Ending September 30th.

Depth in Inches

	Point Lepreau	St. John	Sussex	Moncton	Fredericton Experimental Farm	Fredericton
1919	51.44	49.76	37.77	40.10	35.32	41.79
1920	52.41	53.53	48.97	36.67	34.93	50.15
1921	35.28	37.87	31.42	26.84	29.41	33.73
Mean	39.73	47.47	38.73	34.99	37.01	43.03
Years included in Mean	17	59	18	18	8	15

NOTE One month lacking in Fredericton Experimental Farm, 1919; year computed by utilizing record for that month from other station in proportion of annual mean for the two stations.

With the rainfall at Saint John as a basis, the run-off gauging records compared with the rainfall records during the same year are shown for both Lepreau and Magaguadavic for a total of three years, and with the Musquash for one year only in Table "6."

The notable point in connection with this table is that under the same climatic and precipitation conditions the run-off of Lepreau is 42% higher than the Magaguadavic, all of course, on the square mile basis. Further, Lepreau shows records up to 99% of the rainfall, a thing incredible, while the average over three years is 92%.

The records of the Magaguadavic on the other hand are more reasonable, although high, averaging only 64%.

Table No. 6.

Run-Off Compared With Rainfall Precipitation.

	Lepreaux	West Magagua Musquash	St John davic
Mean run-off inches 1919	45.30"	....	29.78 49.76
Mean run-off inches 1920	46.59"	....	34.05 53.53
Mean run-off inches 1921	37.55	33.60	27.18 37.87
Total run-off 3 years	129.44	....	91.01 141.16
% Run-off to Rainfall '19	91 %	....	60 % ....
% Run-off to Rainfall '20	87%	....	63 % ....
% Run-off to Rainfall '21	99 %	89 %	71 % ....
Mean for 3 years' gaugings	92 %	....	64 % 47"
Comparative % of Run-off	142 %	....	100 % ....

When these gauging records are compared with those from other streams on the Atlantic seaboard although not in this country reported upon by the U. S. Geological Survey, the contrast becomes startling. For the purpose of illustrating this, the records of eight streams as nearly as possible similar in area have been selected for comparison. These records as they have extended for a long period have been discussed by the engineering profession have become almost classics, and are accepted as correct. It will be noted the percentage of run-off in every case is very much lower than the Magaguadavic and tremendously lower than Lepreau.

Table No. 7.

Mean Rainfall and Run-Off Small Areas.

Atlantic Drainage	Years	Area	Rain	Rain-off	% Run-off
Croton	23	339	49.4"	22.8	46
Cochituate	33	19	47.1"	20.3	43
Sudbury	26	78	46.1"	22.6	49
Mystic Lake	18	27	44.1"	20	45
Neshaminy	16	140	47.6"	23.1	50
Perkimon	16	153	48.0"	23.6	49
Tohicon	15	102	50.1"	28.4	57
Pequannock	9	64	46.8"	26.8	57
Magaguadavic	3	574	47	30.3	64
West Musquash	1	76	37.37	33.6	89
Lepreau	3	90	47	43.2	92

Under these conditions of wide discrepancy between gaugings of short duration and the old and seasoned record of rainfall at Saint John, and by comparison with similar areas elsewhere, it is inevitable that for safety in prediction as to the power available one must return to the rainfall record.

The question upon which judgment must be used is as to the percentage of rainfall which may be expected to appear at the wheels in the way of run-off, especially realizing that this water is not in its free state, but is ponded, and therefore evaporation and seepage are inevitably high.

In Table "8" below, the percentage run-off at maximum is allowed at 66 2-3 per cent. of the rainfall of the year; the minimum 45 per cent., and the average over fifty-nine years 55 per cent.

In these allowances the fact is recognized that there will be more percentage run-off during a high precipitation year than during a low. As these percentages are higher than one would care to use for the purpose of predicting the amount of power available in advance of construction, especially when it is considered that all water in this case is to be stored, the results are considered to be such as to do the power output no injustice but rather the reverse.

Table No. 8.

Output on Basis Of Rainfall Records at St. John For Fifty-Nine Years.

Based on Rainfall Alone.	Maximum 1886-87	Minimum 1910-11	Mean. 1861-1920
Extreme and Mean Rainfalls	58.51"	36.70"	47.47"
Rainfall inches per year	66 2-3%	45%	55%
Allow % in Run-off	39"	16.5"	26.1"
Run-off in inches			

Power Available At Saint John.

In a previous page of this report it was shown that a depth of run-off of 39.12 inches was necessary to provide 21,000,000 kilowatt hours at Saint John, while gaugings in the West Musquash for 1921, indicate a run-off of 33.60 inches, during which time the Saint John precipitation records amounted to 37.876. This is not by any means the lowest rainfall record at Saint John that of 1910-11 being 36.70 inches, from which, if we assume a proportioned run-off the lowest ganged record should give 32 inches of run-off.

The minimum power available at Saint John during the year of lowest rainfall record at Saint John would therefore be 21,000,000 k. w. h. multiplied by 32, and divided by 39—17,000,000 k. w. h. On the same basis, the other records in Table "8" show the following:

Table No. 9.

Power Available At Saint John.

	Run-off Inches	Power at St. John
From gauging records, the lowest power available in 59 years	32	17,000,000 k.w.h.
By precipitation readings maximum run-off (table 8)	39	21,000,000 "
By precipitation readings mean run off (table 8)	26.1	14,000,000 "
By precipitation readings minimum run-off (table 8)	16.5	9,000,000 "

If the gauging records are right Saint John may expect from the Musquash 17,000,000 k.w.h. during the minimum year. If these are not found to be correct and the precipitation records govern, it cannot be predicted that more than 9,000,000 kilowatts will be available as a minimum. This will cover the present requirements at Saint John for Light, Power and Street Lights in all totalling 6,250,000 k.w.h., but it will not cover the requirements of the Company which include in addition those of the street railway, in all 12,000,000 k.w.h. in 1920.

Should it develop that the Musquash does not come up to the Commission's expectations, or even if it does, a steam plant would be advisable to supplement the water power and enable the output of the project to be greatly increased over the minimum, so that new hydraulic plants when developed will not have to remain unloaded or only partially loaded for years after construction.

This Steam Plant, supplementing as it should the Hydro-Electric Plant, should be owned and operated by the Government so that they may carry out their own programme of use of water and catch every flush as it comes, using the steam station to keep the pondage up during critical periods, and to carry the peaks of whatever service is demanded either from Saint John or elsewhere. This question of a Steam Plant is dealt with fully in the second part of this report, and is there charged to the cost of distribution but should in justice be debited against the power purchased.

The serious part of this question relates to the cost per kilowatt hour which has to be charged to someone. With an anticipated output of 21,000,000 k.w.h. which must, of course, be reckoned on the lowest year, unless a steam plant be provided, the cost can be met at the rate of 1.3 cents per k.w.h.

By whatever amount the sales fall below the above output, the cost per k.w.h. will increase in inverse proportion and must be paid by someone.

(Continued on page 5)

Europe's Troubles Must Involve The United States

There Can Be No Return to Normality in U. S. Until Europe Is Settled.

Boston, Feb. 11.—"Every crisis in Europe involves the United States, and no attempted policy of isolation can free us from this fact," declared Frank I. Cobb, editor and chief editorial writer of The New York World, in an address before the Boston Chamber of Commerce at the Copley Plaza hotel yesterday noon. Mr. Cobb insisted that this country should join a league of nations without delay and should be represented at the Genoa conference. "The conference at Washington has brought us back into step with the rest of the world," he said.

"There can be no return to normal conditions in the United States until something approximating stability has been secured in Europe," he asserted. "The origin of this confusion was not in the United States and the solution is not here. The basis of business is not money; it is credit. And credit is a matter of confidence; it depends upon economic and political stability.

Chinese Ancestor Worship.

"Our foreign policy is a curious perversion of Chinese ancestor worship. It is nominally derived from Washington's farewell address, made in 1796.

"It would astonish no one so much as Washington to find that his utterance had been ordered into a permanent policy. At the time Washington spoke he was having trouble with the French Revolution and a lot of fool Americans who almost got the United States into the war.

"We had an alliance with the Most Christian King of France, but the enthusiastic subjects of the Most Christian King showed their regard for him by chopping off his head. Then the French remembered the alliance and thought it still held good, but a lot of hard-headed Yankees and Virginians thought it didn't. So Washington got up and said, in effect, 'Mind your own business, and don't get mixed up in what doesn't concern you.'

"It was good advice for the particular occasion, but it was no more a declaration of foreign policy than Wilson's word at the beginning of the world war, 'Be Neutral.'"

Mr. Cobb compared the recent conflict with the War of 1812, declaring that in one we had been drawn into the Napoleonic wars and in the other into the World War. This, he stated, showed that we had been drawn into the only two great crises in our existence. "The policy of isolation works well when everything is all right in Europe, but not otherwise," he said.

"Formula for Victory Found."

Referring to Mr. Wilson, Mr. Cobb told of having visited him in Washington in the summer of 1918, saying: "Of all the men in Washington he was the only one that was not worried about the war. 'The formula for victory has been found,' he said. 'It is a matter of putting men and supplies into Europe. The lines of communication cannot be cut, and the end of the war is a matter of months. But I am worried about the political and economic readjustments which will come out of the war. No one is thinking about them now, yet the most stupendous readjustments which the world has ever seen will be necessitated after the war.'

"That was four years ago, and the problems he mentioned are still with us," the speaker continued. "We have not made much progress. In some respects we have gone backwards and are worse off than we were at the end of the war."

M. Cobb highly commended the work of the Washington Conference, and urged the extension of our foreign policy to include Europe as well as Asia.

Says Acid Stomach Causes Indigestion

Excess of Hydrochloric Acid Sours the Food and Forms Gases.

Undigested food delayed in the stomach decays, or rather, ferments the same as food left in the open air, says a noted authority. He also tells us that Indigestion is caused by Hyperacidity, meaning, there is an excess of hydrochloric acid in the stomach, which prevents complete digestion and starts food fermentation. Thus everything eaten sours in the stomach much like garbage sours in a can, forming acrid fluids and gases which inflate the stomach like a toy balloon. Then we feel a heavy, lumpy misery in the chest, we belch up gas, we eructate sour food or have heartburn, flatulence, water-brash or nausea.

He tells us to lay aside all digestive aids and instead, get from any pharmacy four ounces of Jad Salts and take a tablespoonful in a glass of water before breakfast and drink while it is effervescing and furthermore, to continue this for a week. While relief follows the first dose, it is important to neutralize the acidity, remove the gas-making mass, start the liver, stimulate the kidneys and thus promote a free flow of pure digestive juices.

Jad Salts is inexpensive and is made from the acid of grapes and lemon juice, combined with lithia and sodium phosphate. This harmless salts is used by thousands of people for stomach trouble with excellent results.