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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

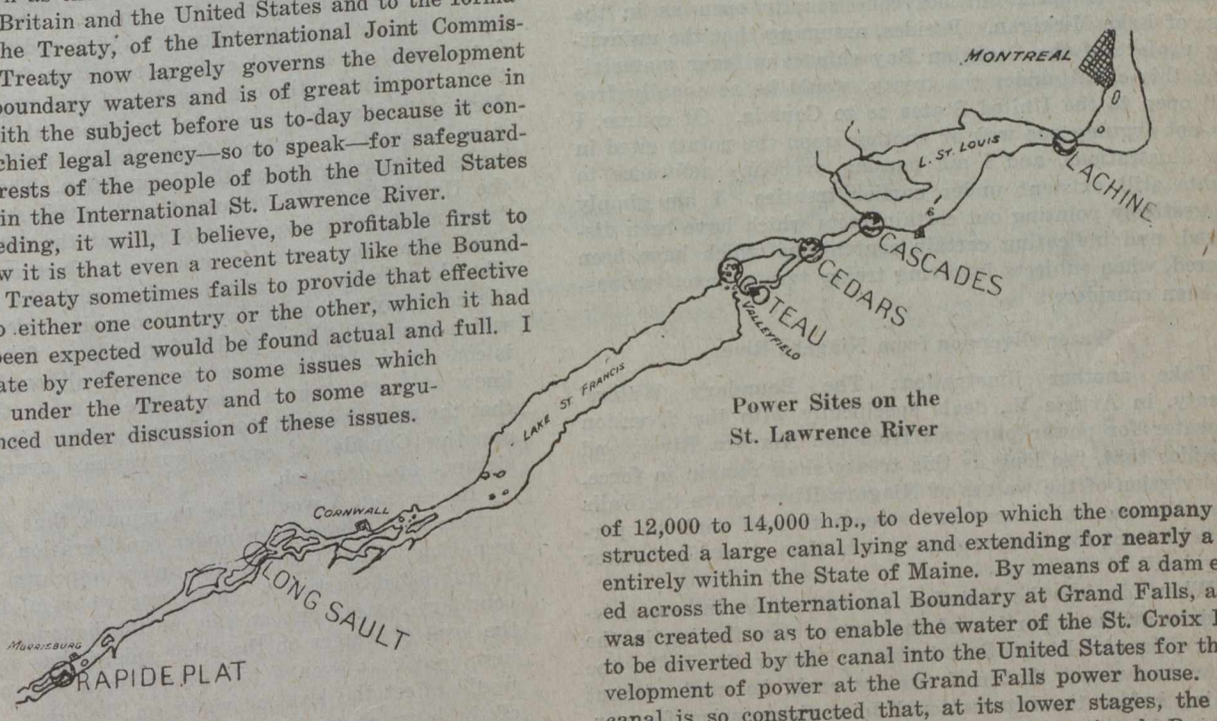
Canada's Heritage in the St. Lawrence River

Must Not Be Compromised by the Erection of Structures in the Main Stream for Piecemeal Development of Power—Integrity of the St. Lawrence River Must Be Preserved for Deep Draft Navigation—Address Given Last Month Before the Electric Club of Toronto

By ARTHUR V. WHITE
Consulting Engineer, Commission of Conservation

ABOUT a year ago, when I had the pleasure of addressing the Electric Club, as you may recall, we traced the evolution of the circumstances associated with power development on the Niagara River, and noted how those circumstances led up to the ratification of what is known as the *Boundary Waters' Treaty* of 1910 between Great Britain and the United States and to the formation, under the Treaty, of the International Joint Commission. This Treaty now largely governs the development and use of boundary waters and is of great importance in connection with the subject before us to-day because it constitutes the chief legal agency—so to speak—for safeguarding the interests of the people of both the United States and Canada in the International St. Lawrence River.

In proceeding, it will, I believe, be profitable first to point out how it is that even a recent treaty like the Boundary Waters' Treaty sometimes fails to provide that effective protection to either one country or the other, which it had confidently been expected would be found actual and full. I shall illustrate by reference to some issues which have arisen under the Treaty and to some arguments advanced under discussion of these issues.



Power Sites on the St. Lawrence River

Let me here comment, that the best safeguard the citizens of Canada can have in matters affecting their natural resources, is an intelligent understanding of the real value of their assets and of the best uses to which they may be applied, coupled with a quick and discerning appreciation of what constitutes any menace to these interests, and of how to act promptly for its removal. Menace to public interest often manifests itself in obscure and subtle forms.

Let us proceed to consider a few illustrations which, owing to limitations of time, can here only be referred to suggestively.

St. Croix River Application

The boundary line between the State of Maine and the Province of New Brunswick passes along the St. Croix River—a stream of considerable size. Four or five years ago United States financial interests controlling the St. Croix Paper Co. of the State of Maine, and operating in Canada through the Sprague's Falls Manufacturing Co., Limited—a company with a Canadian charter—undertook to increase the power installation which they already had upon the St. Croix River by erecting a new plant in the vicinity of what is known as the Grand Falls, situate about ten miles above Woodland, Me. The additional installation was to consist of 12,000 to 14,000 h.p., to develop which the company constructed a large canal lying and extending for nearly a mile entirely within the State of Maine. By means of a dam erected across the International Boundary at Grand Falls, a lake was created so as to enable the water of the St. Croix River to be diverted by the canal into the United States for the development of power at the Grand Falls power house. This canal is so constructed that, at its lower stages, the total flow of the St. Croix River—an International Boundary stream—may be diverted into the United States. This company, *after* constructing their works, came before the International Joint Commission, pleaded ignorance of the law, drew special attention to their vested interests, and were finally granted a permit to utilize the works under terms greatly to their advantage.

Now, the treaty provides that, after its acceptance, no diversion from boundary waters, whether "temporary or permanent," shall be made without obtaining the necessary authority. When the St. Croix case was under discussion, counsel suggested that the word "temporary" might not mean temporary with respect to time, but temporary with respect to place. That is to say, that the diversion of the St. Croix River was not out of accord with the treaty because the river was only diverted temporarily; that is, it

was "temporarily" turned aside for a short distance and then resumed its normal course.

Navigation on Lake Michigan

Consider the next illustration: The Boundary Waters' Treaty defines boundary waters as "the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the International Boundary between the United States and the Dominion of Canada passes, including all bays, arms and inlets thereof, etc." And the treaty also states: "It is further agreed that so long as this treaty shall remain in force, this same right of navigation shall extend to the waters of Lake Michigan and to all canals connecting boundary waters and now existing or which may hereafter be constructed on either side of the line."

Now, the treaty, subject to certain restrictions, stipustates "that the navigation of all navigable boundary waters shall forever continue free and open for the purpose of commerce to the inhabitants and to the ships, vessels and boats of both countries equally," and one not acquainted with possible interpretations suggested for portions of the treaty, is naturally surprised to learn that it has been contended that Lake Michigan is not a boundary water—although a geographically corresponding body of water in Canada, the Georgian Bay, is such,—and the treaty suggests, inferentially, that Lake Michigan is only conditionally open to navigation, while Georgian Bay—the Bay is not specifically mentioned—is open, but not conditionally open as in the case of Lake Michigan. Besides, assuming that the uninviting project of the Georgian Bay ship canal ever materialized, this canal, under the treaty, would be as equally free and open to the United States as to Canada. Of course, I am not arguing one way or another upon the points cited in my illustrations, and I am passing over any reference to rights still existent under earlier treaties. I am simply suggestively pointing out certain facts which have been disclosed, and indicating certain contentions which have been offered, when subjects involving treaty terms, have, variously, been considered.

Water Diversion from Niagara River

Take another illustration: The Boundary Waters' Treaty, in Article V., deals specifically with the diversion of water for power purposes from the Niagara River, and provides that, "so long as this treaty shall remain in force, no diversion of the waters of Niagara River above the Falls from the natural course and stream thereof shall be permitted except for the purposes and to the extent hereinafter provided."

When, during the last few years, certain interests desired to utilize a portion of the waters now flowing in the lower Niagara River, that is to say, below the Falls, the claim was urged that such waters could be used without coming before the International Joint Commission for permission, because it was contended that the treaty only dealt with diversion of water above the Falls and did not specify where the water should be returned. In other words, some interests hold that, under Article V., the International Joint Commission has no jurisdiction to deal with any diversion in the Niagara River other than with diversion made from "above the Falls." The water, it was argued, could be taken out *above* the Falls and turned, if users so desired, directly into Lake Ontario without coursing the lower Niagara River.

Application of St. Lawrence River Power Company

While illustrations might be multiplied, we shall here consider only one other instance. This arose during the past summer in connection with the application of the St. Lawrence River Power Company respecting the construction of works in the vicinity of, and the diversion of waters from, the Long Sault Rapids. The St. Lawrence River Power Company is a subsidiary company of the Aluminum Company of America, which, amongst other activities, operates a large aluminum-producing plant at Messena, N.Y. The St. Lawrence River Power Company desired to construct works in the St. Lawrence which would, so far as possible, remove ice difficulties which affected their winter output. To this end they excavated, largely in rock, a long channel, 25 feet deep by 150 feet wide, in the bed of the St. Lawrence River. Complementary to this excavation there was to be a large boom held by rock-filled cribs, some 30 feet square, sunk in the St. Lawence River. Below the dredged channel just referred to, there was also to be constructed in what is known as the South Sault Channel—that is, the passage nearest the United States' shore—a "submerged weir," which, actually, is a large submerged dam. The work of channel excavation was undertaken, and practically completed under permit from the United States War Department, without the matter in any way being brought to the official attention of the Canadian authorities.

A War Measure

The Boundary Waters' Treaty provides that there shall not be "any interference with or diversion from their natural channel of such waters on either side of the boundary" as will result in any injury on the other side of the boundary. If the enlarged channel remained, then the proposed submerged weir had to be constructed in order to compensate for alterations in level already resulting from the excavation. Incident to the construction of this weir the company deemed it desirable to obtain the approval of the International Joint Commission. Consequently, an application was made for hearing before the Commission. The company and the United States Government authorities stated that as a "war measure" it was necessary that the company be supplied with more power in order to produce more aluminum. The Commission was urged to deal with the application of the company without delay and to waive rules of procedure which constitute the usual safeguards so far as the public is concerned.. This course was urged although the company knew at least about a year before it made the application that the proposed dam would be necessary. Upon the war necessities Canada, of course, guaranteed every possible assistance and despatch.

In passing, I would like to remark that at times when certain issues have been under consideration before the International Joint Commission, and it appeared advantageous to interested parties to show how what might be done in boundary waters on one side of the boundary would affect the level of waters on the other side, it has sometimes been instanced that even a pile driven in a stream on one side would affect the level of water on the other. In the case of the large channel to which reference has just been made, which substantially affected levels in the river and adversely affected Canadian navigation, counsel for the applicant company argued that interests would really not be disadvantageously affected because when the large cribs and the dam was in place disturbed levels would then be restored.

"Free and Open"

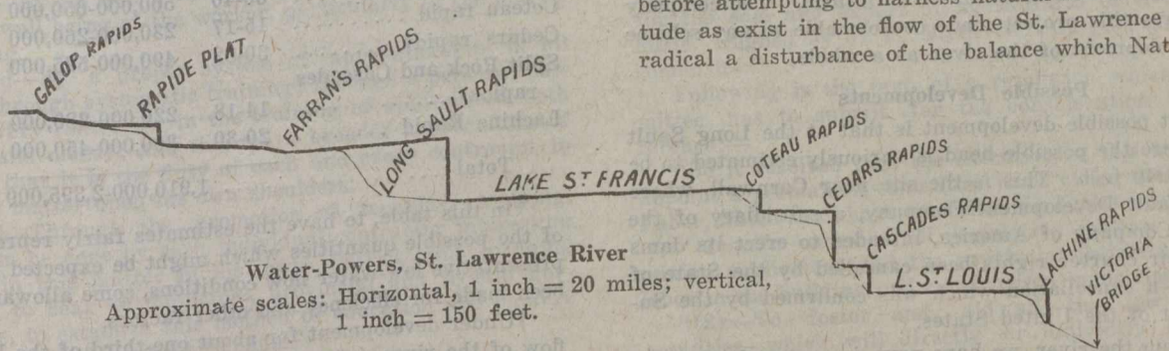
Under the Webster-Ashburton Treaty it is specifically provided that the channels in the St. Lawrence River on both sides of the Long Sault, Barnhart and Croil islands were to be kept "free and open to the ships, vessels and boats of both parties." So that, in any event, if the South Sault Channel were blocked by a dam, a navigable channel which was to be kept open by treaty right would be closed, and a public liberty and right which could not be justified under the spirit and intent of the treaty would be enjoyed by private interested parties.

Now, although the construction of the works referred to was, in the judgment of many, a violation of the spirit and terms of the treaty, the company, neverthelesss, aided by their representations respecting the allies' war necessity, were able to obtain a permit to construct this dam and to have it remain in place for five years or for the term of the duration of the war, whichever term should be the longer. You will notice it was not specified which term should be the *shorter*. At the time of Hearing before the International Joint Commission the solicitor-general of Canada, the Hon. Hugh Guthrie, on behalf of the Government of Canada made a special, solemn and very able protest against the granting of the permit except under conditions which he outlined, and which, while meeting temporary needs, would fully preserve the integrity of what he contended to be Canada's rights under the Webster-Ashburton Treaty.

From the foregoing illustrations it will be evident how necessary it is for our leading public men, especially those in Parliament, to have a good understanding of Canada's natural heritage in boundary waters and of means which must be taken properly to conserve this heritage for the benefit of her citizens.

Navigation of St. Lawrence River

We shall now consider, very briefly, some more concrete aspects of the subject which to-day has our chief attention: "Canada's heritage in the St. Lawrence River."



Water-Powers, St. Lawrence River
Approximate scales: Horizontal, 1 inch = 20 miles; vertical, 1 inch = 150 feet.

First, just a few words with respect to navigation. The St. Lawrence as the wonderful water highway from the Great Lakes to the sea has, as you know, been improved chiefly by the canal systems of the Government of Canada. The new Welland Canal is being constructed with locks of 30 feet draught. If it is to be used so that deep-draft, ocean-going vessels may go up to the head of navigation of the Great Lakes, then the St. Lawrence River in portions of its main channel will have to be canalized by means of a series of dams with suitable locks. If the river as a whole be canalized, obviously the water power of the river would be most economically developed by having the dams necessary for the navigation improvement made adaptable also for the development of water-power. One fact is certain, and that is, that, in order to conserve the integrity of the St. Lawrence River so that it may suitably be canalized—when the time comes for such work—its integrity must not be compromised by permitting the erection of structures in the main stream for piecemeal development of power, although this has already been done to some extent. Naturally, there is a great temptation for water-power companies to do on the St. Lawrence as has been done elsewhere, namely, to make the cheapest possible preliminary developments—skim the cream off the powers, so to speak—for by so doing interests may readily acquire markets, and vested rights, and often control of the general situation.

I shall not further refer to Canada's heritage in the navigability of the St. Lawrence. In a word, it may be summed up that deep-craft navigation from the Great Lakes to the sea involves, absolutely, the treatment and canalization of the St. Lawrence River as a unit.

Water-Powers of St. Lawrence River

Coming next to the heritage of water-powers, I would remark first that the water-powers of the St. Lawrence River are, as yet, largely within the control of the people. The recent shortage of hydro-electric power which has been so keenly felt, both in Canada and the United States, has drawn increased attention to the enormously advantageous powers in and adjacent to International Boundary waters. Most of the water-powers which are more readily capable of economic development in Canada as well as in the United States either have already been developed or are privately controlled. Concentration of ownership is a noticeable feature of this control. Canada cannot afford to have her St. Lawrence River powers pass into the hands of powerful private interests.

Some Governing Factors

With respect to development of these water-powers, there are some very important points upon which I must just comment, such as ice conditions, the exportation of Canada's share of electrical energy and the character of the agencies utilizing the power.

Respecting Ice.—Power development on the St. Lawrence River cannot properly be considered apart from the subject of the ice menace. Too great caution cannot be exercised before attempting to harness natural forces of such magnitude as exist in the flow of the St. Lawrence River. Too radical a disturbance of the balance which Nature seeks to maintain may cause disaster, hence it is well to emphasize this phase of the problem, for it involves the weighing of basic physical factors of paramount importance.

Respecting character of consumption of power.—Where very large developments of power take place it is, as you know, usually necessary to have some industries, such as the electro-chemicals, take large blocks of power. These industries require cheap power. As the demand for power increases for municipal and small manufacturing purposes the experience has been that the demands for power for such uses become so urgent, and the inducements by way of price so attractive to the vendors of such power, that large industries which were attracted by the cheap power have been compelled to go farther afield. A block of power—over 65,000 h.p.—such as is exported from the Cedars plant in Quebec to the Aluminum Works at Messena, N.Y., would be sufficient, speaking on a broad basis, to supply light and power to some 35 manufacturing cities of 10,000 inhabitants each. It will be apparent from a comparison of the benefits resulting from power thus widely distributed and the localized benefits from the same power utilized in bulk, as in electro-chemical industries, that the former contributes in a much greater degree to the upbuilding of communities and to the growth of the country at large. This feature should not be lost sight of.

Respecting the Exportation of Electrical Energy.—There is strong opposition, especially throughout Ontario, to any

policy which permits the exportation of electric energy really required for use in Canada. The Federal Government has been memorialized upon this subject. It has been urged that no large power projects such, for example, as those on the international portion of the St. Lawrence River, should be developed without reserving Canada's share of the power for use here; and, further, that powers situated wholly in Canada should be reserved against the day of Canada's need. This statement is made having in mind the fact that it is not the policy of Canada to embargo her exports, but that commodities of national importance should not be exported without an adequate *quid pro quo*.

[The speaker at this part of his address made use of charts, corresponding to the diagrams reproduced herewith, showing situations of the respective power sites and profile of the river.—EDITOR.]

On the St. Lawrence River below Lake Ontario the first site where development involving the whole flow of the river could be made is in the vicinity of Morrisburg. With a dam near the foot of Ogden Island, a head of about 11 feet could be obtained, or, by taking in a portion of the Galop rapid, it has been thought possible to obtain a total effective head of about 15 feet. It is at this Morrisburg site—the Rapide Plat—that the New York and Ontario Power Company develops power in a small plant at Waddington, N.Y., under rights extending back for one hundred years. This company desires to reconstruct this plant and increase the development, thereby providing power for disposal in the United States as well as in Eastern Ontario. The company offers to have this project made conformable to any scheme for the development of the river as a whole.

Possible Developments

The next possible development is that at the Long Sault Rapids, where the possible head is variously estimated to be about 35 to 40 feet. This is the site near Cornwall, where the Long Sault Development Company, a subsidiary of the Aluminum Company of America, intended to erect its dams had not their charter rights been cancelled by the State of New York—a cancellation which was confirmed by the Supreme Court of the United States.

Descending the river, we have next, in a stretch of about 14 miles between Lakes St. Francis and St. Louis, three series of rapids: the Coteau, the Cedars, the Split Rock and Cascades. The Coteau site is the one for which the Power Development Company, Limited, has been seeking rights. Of this company the "Montreal Star" states:

"There was incorporated, by letters patent a modest company, with a capital of $500,000, the incorporators being the bookkeepers of a well-known law firm in Montreal, closely associated with certain existing companies. . . . A modest notice appeared in an obscure newspaper with a small circulation . . . . . and there was quietly filed a declaration in the Registry Offices of the counties where the proposed development is to be made, indicating that no less a scheme is on foot than the building of a dam across the St. Lawrence River."

Reliable assurances, however, have been given that rights for this development cannot be obtained without full public notice and discussion when all interested parties will have the opportunity of being heard.

The Cedars Rapids Manufacturing and Power Company utilize at Cedars rapids a head of about 32 feet developed by means of a diversion canal some two miles long. The power house has been designed for an ultimate development of 180,000 h.p. This company exports some 65,000 h.p. to Massena, N.Y.

The Soulanges plant of the Civic Investment and Industrial Company is situated a short distance below the Cedars plant. Power is obtained by tapping the Soulanges canal. The head is 50 feet.

The St. Timothee plant of the Canadian Light & Power Company is on the south side of the St. Lawrence directly opposite the two last mentioned developments. The water is led through a portion of the old Beauharnois canal. The head is 50 feet, and the development has an ultimate capacity of about 75,000 h.p.

I shall omit description of some other smaller plants, such as those at Mille Roche and in the vicinity of Morrisburg.

To summarize, we may place the estimated low-water power of the international portion of the River St. Lawrence at about 800,000 h.p., of which Canada is entitled to one half, or 400,000 h.p. The potential low-water power on the portion of the river which lies wholly within Canada would be 1,400,000 h.p. This, with its share of power along the International Boundary, makes an estimated total for Canada of 1,800,000 low-water continuous horse-power. It is detailed in the following table:—

Water-Power on the St. Lawrence*
(Tentative Schedule)

Site	Head available	Estimated low-water 24-hr. h.p.	Average estimated 24-hr. low-water h.p.
Morrisburg-Rapide Plat	11-15	170,000-230,000	200,000
Long Sault rapid	30-40	500,000-650,000	575,000
Coteau rapid	15-17	230,000-260,000	250,000
Cedars rapid†	30-32	490,000-525,000	500,000
Split Rock and Cascades rapids	14-18	220,000-280,000	250,000
Lachine Rapid	20-30	300,000-450,000	375,000
Total	.....	1,910,000-2,395,000	2,150,000

*In this table, to have the estimates fairly representative of the possible quantities which might be expected under representative low-water flow conditions, some allowances have been made for efficiency and other factors.

†Under development for about one-third of the low-water flow of the river. Consideration would be given to the possibility of combining the Coteau, Cedars, Split Rock and Cascades; also of increasing the Lachine power.

The above estimate, excluding ice conditions, is conservative. Under a "diversity load factor," such as is experienced by the Hydro-Electric Power Commission of Ontario, Canada's 1,800,000 h.p. would take care of a power demand of some 2,400,000 h.p.

Canada's share of this power belongs respectively to the provinces of Ontario and Quebec. The Federal Government has the rights in and jurisdiction over navigation. When the time comes for international questions in connection with the development of this river to be adjusted to admit of proper development, there is no doubt that the various interests involved, whether federal, provincial, corporate or private, will, respectively, be fully taken care of. Perhaps, for example, some arrangement may be made by which the Federal Governments shall provide the dams for navigation purposes, making available for each province its share of water-power under an arrangement by which the provinces would assume such financial and other responsibilities as were purely incident to the power assets.

I trust I have adequately emphasized the absolute necessity for statesmanlike dealing with our resources of boundary waters, the wise conservation, utilization and administration of which will help build up Canada and pay our future taxes.

LABOR, APPRENTICESHIP AND TECHNICAL EDUCATION*

IT is the unanimous opinion of this committee that all labor should be paid not only a living wage, but such as will ensure to every worker such of the amenities of life as will enable him to be a contented and happy citizen of Canada.

It is an axiom that rates of wages are controlled neither by employer nor by employed, but by an immutable law over which neither party has control.

It is to be remembered that in the end it is not the employing contractor who pays the wages of labor, but the vast consuming public of which labor is a large part. Therefore, with the exception of setting out the above, the question of wages of labor is not in our province.

Vital to the Building Industries

It is, however, vital to the building industries that they concern themselves with the quality of labor, and it is the recommendation of this committee that the conference appoint a permanent committee on labor, to watch all legislation pertaining to same, and to foster every endeavor for the proper manual and technical education of those who labor at the work of the trades in which we are interested, so that labor of every kind may become more skilled. The avenues which present themselves to us, as contractors, for the furtherance of the upbuilding of our labor in skill and usefulness, are three, viz.:—

First—By an active interest in all that pertains to the physical well being of the worker, particularly in the matter of housing.

Second—By a proper system of apprenticeship in all trades; through systematic training; through a personal outlay by every contractor in the training of apprentices, both of time and money; and through a broader appreciation of the fact that it is the duty of each and every contractor to take this matter upon his own shoulders.

Third—Through the promotion of technical training, which can be done by each individual contractor interesting himself in this matter in his own district and bringing pressure to bear on municipal, provincial and federal governments, to establish this method of education and enlarge the scope of it throughout Canada.

Memorial to the Government

This committee is further of the opinion that a memorial should be prepared by this permanent committee for presentation to the Dominion government, urging the vital necessity of an immediate large financial grant at the next session of parliament, for the furtherance of technical education, and with this in view, has appointed a sub-committee to ascertain the present position of the Dominion government towards technical education, and to collate such data as would form the basis of a memorial. This sub-committee's report is as follows:—

"We beg to submit the following memorandum re position of Dominion government towards technical education, as containing data for the preparation by a committee of the Association of Canadian Building and Construction Industries of a memorial to be presented to the Dominion government.

"Up to the present time the Dominion government has not given any financial assistance to the promotion of technical education.

"The activities of the Dominion government in this matter have consisted in the appointing of a commission, under Dr. J. W. Robertson, to make a thorough investigation of technical education. In 1913 this commission submitted a report. This report was published and has had wide distribution.

"Financial aid or assistance has been granted by the Dominion government; firstly, $1,000,000 per annum for the furtherance of agricultural education; secondly, a substantial amount yearly for the furtherance of education in the Fisheries Branch; and thirdly, the sum of $90,000 annually for the promotion of industrial research.

"The recommendation for financial assistance by the Dominion government for technical education made in Dr. Robertson's report, consisted of $3,000,000 per annum for a period of ten years, and $350,000 per annum for pre-vocational work in the schools.

"It is to be noted that this recommendation was made prior to the war, and it is the opinion of this committee that, provided the amounts asked for in Dr. Robertson's report will take care of the requirements of Canada in technical education in co-operation with the provincial and municipal governments, conditions in Canada to-day warrant and imperatively called for the making available immediately of a vastly greater initial sum of money, so that an immediate stimulus may be given to this vital matter and the young soldiers returnig to civil life can be benefited thereby.

Fully Discussed by Premiers

"It is a matter for the expression of great pleasure that in the late conference between the Dominion Cabinet and the premiers of the various provinces, this question of technical education was fully discussed, and that warm interest was shown by the members of the Dominion Cabinet.

"It should be emphasized in this memorial that for the upbuilding of Canada, it is just as vitally necessary that the Dominion government provide money for technical education of the workers of Canada as they should provide for the upbuilding of the ship-building industry or provide credits for the sale and export of agricultural or live stock products. Signed by J. T. Blyth and G. F. Frankland, subcommittee."

Following is the text of a resolution which your committee has to submit for the consideration of the conference:—

"Be it resolved that the executive of this association do appoint a permanent committee to be called a Committee on Labor, which shall have the following duties assigned to it:—

"(1)—To consider all legislative matters in the Dominion parliament and the provincial legislatures affecting labor in the building and construction industries.

"(2)—To foster and aid all the movements and activities which will directly or indirectly increase the efficiency of labor, physically and mentally, and improve its quality, particular attention being given to the following:—

"(a)—The housing of the worker.

"(b)—The development of the apprenticeship system.

"(c)—The immediate establishment and furtherance of technical education throughout Canada."

Committee on "Labor Conditions":—G. A. Crain, Ottawa (chairman); D. K. Trotter, Montreal; W. A. Quinlan, Montreal; J. R. Douglas, Ottawa; J. F. Schultz, Brantford; W. J. Green, St. Thomas; Alex. I. Garvock, Ottawa; Wm. Weller, Toronto; Jno. W. Litton, Kingston; F. C. Woodroffe, Montreal; Thos. Painter, Toronto; W. S. Bellows, Fort William; Jos. Gosselin, Jr., Quebec; W. A. Wilson, Regina; J. Phinnemore, Toronto; H. Palmer, Chatham; A. Tomlinson, Chatham; N. K. Reid, Toronto; J. T. Blyth, Ottawa; G. F. Frankland, Toronto; E. R. Dennis, London; J. Mantel, Hamilton; G. Perrier, Halifax; A. Matthews, Toronto.

*Report of committee to the Ottawa Conference of the Association of Canadian Building and Construction Industries.

As previously announced, orders have been placed through the War Trade Board for 200,000 tons of steel rails to meet the requirements of the Canadian Pacific, Grand Trunk and the Government Railway systems, the value of this order being about $10,000,000. In addition the boards of directors of the several railway companies will proceed with the construction of such car equipment and locomotives as are needed. It is understood that the Canadian Pacific and the Grand Trunk will fill their requirements in their own shops. The aggregate value of car and locomotive equipment required by the several railways will be from $12,000,000 to $15,000,000.

SEWAGE DISPOSAL FROM AN OPERATOR'S STANDPOINT*

By William K. F. Durrant, Moose Jaw

THE problem of sewage disposal is one which is receiving serious consideration from sanitary and other authorities, and will become more important as the smaller towns and villages increase, and the pollution of the rivers and streams must be minimized to as great an extent as possible. Especially is this so in the middle West, where the scarcity of water is so great that many people have to depend for their water supply on the smaller waterways which form a convenient channel for the discharge of the sewage of larger cities situated on their banks. The cost of installation of disposal plants is large, and it behoves the authorities undertaking such work to examine carefully the many systems offered, so that the maximum efficiency can be obtained with the minimum of expense. Installation may be expensive, but is comparatively small compared to the expense of having to change one system for another on account of inefficiency of service.

I do not pretend to be an expert on the matter, but my experience may prove useful to young sanitary inspectors, who probably have had no practical training in this important branch of sanitary work.

I may say, at this point, that more importance should be attached to the position of chief operator than at present obtains. Usually the position is open to men who understand the running of the pumping station, but have no qualifications or desire to understand the reasons for the plant, and are probably indifferent to the significance of a well-treated sewage. The man responsible for the treatment has probably many other duties, and can only spend an hour or so per day, or even per week, to the superintendence of the plant. The operator may have enough work on his particular end to keep him busy during most of the time, with the result that the efficiency of the plant may be curtailed. Interest can only be maintained by allowing the man in charge a proper salary, and by instructing him in the nature of the work, and allowing him to see for himself the results obtained, the methods of obtaining them, and the necessity for maintaining a maximum amount of efficiency. In a word, he should be trained until he can himself take full control of the plant, with the occasional supervision of the engineer or chief inspector, as the case may be, to check his work. This would probably entail a little more expense to the city, in having to hire more help, but I feel confident the expense would be justified by better results.

The plant with which I am connected consists of a detritus pit and screen chamber, pump house, plain sedimentation tanks, bacteria beds, disinfecting chambers and humus pond.

Taking each in turn, from the entry of the sewage until its final discharge, I intend to comment on each, giving my ideas as to improvements, and possibly opening up channels for profitable discussion to all concerned.

Detritus Pit and Screen Chamber

These should be at least in duplicate, and deep enough to hold at least a day's deposit, which I think I should be safe in estimating about a ton. The screens should not be more than three-quarter inch, in order to prevent rags and stringy material from passing through. Since the installation of the pail system, we have had to contend with a large amount of this matter, especially in winter. The pails are placed in warm water, until the contents are thawed from the sides, and then dumped into the sewage, which gradually thaws the blocks. As with other sanitary arrangements, if the people were educated to the point of using the pails for the legitimate purpose for which they are intended, this method would probably be a success. But it has been found that rags, tins, bottles, etc., find their way into the pails, with the consequent result that we have had to handle at the screen chamber, matter which should never be in the sewer at all. Arrangements are likely to be made to remove the pail house to the power plant, where steam can easily be obtained to thaw the contents, and remove the rags, etc., before passing into the sewers.

After passing the screen chamber, the sewage passes into the pump house, and just inside the screen chamber is a convenient point to place the by-pass, which will take care of the extra water in case of flood. The pumping plant should be large enough to take care of the full quantity of sewage, according to the size of the city, but in case of extra pressure caused by flood water, or unavoidable breakdowns in the plant, a by-pass is an almost absolute necessity.

The Pump House

The installation of the pumping units is probably the hardest problem of the whole system. Unless wisely installed, it may give rise to serious trouble and entail large expense until the most serviceable unit is obtained. Sewage, unlike other classes of water, is apt to contain rags, string, waste, and other matter which is not wholly held back by the screen, and causes inconvenient blocks in most pumping units.

With regard to the turbine, I was afraid at first that it was going to be an absolute failure, owing to the ease with which it becomes blocked with rags. By using the ejectors, however, the first thing in the morning, when the sewage is light, and thoroughly cleaning the screen of all matter collected, before starting the centrifugal, I found the pump could be run with a fair amount of success, generally with a few minutes' attention every hour or two. The total cost of pumpage has been lowered from between $15 and $16 per million with the ejectors to between $5 and $6 per million with the turbine.

Sedimentation Tanks

Leaving the pump house we next come to the sedimentation tanks. Here should be deposited all the flocculent matter in the sewage if the bacteria beds are to be efficient. There are three tanks with a capacity of about 96,000 gallons each. When all are in operation the sewage passes through them quietly, probably taking from two to four hours in its passage, and depositing the solid matter on its journey through. We find that a tank requires emptying in about nine weeks, the deposit being close enough to the surface to interfere with the efficiency of the system. I think that if a double system of tanks was installed, instead of a single system as at present, the efficiency of the tanks would be greatly increased. At the seventh or eighth week, the sediment is becoming very close to the flow of water, the capacity of the tank is lessened, and the danger of the sewage passing through without proper sedimentation is very pronounced. Now, if there was a double system, most of the solids would be deposited in a primary set of tanks, which would be emptied as at present and any which had passed through without sedimentation would deposit in the secondary set, which would probably go a long time before requiring

*Abstracted from "Western Municipal News."

emptying. The great danger of such a system would be that of turning the sewage septic, which I think would be only slight. I should like to hear some opinions on this subject, as I think a great part of our trouble with the sewage is in not being able to get complete sedimentation, thereby throwing more work into the bacteria beds than they are able to perform. I think also that a properly constructed screen fixed at the outlet weir would be a great help in keeping back fat and other light matter. The screens I have in mind would be made after the style of Stoddart's trays, which, placed in certain positions, will not allow solid matter to cling to them, but owing to their formation compel the accumulation, when of sufficient weight, to slide off. I may here be allowed to state our method of sludge removal. The water of the tank is drained off, and the sludge falls by gravity through a large pipe into the ejector from whence it is driven out by compressed air, onto prepared sludge beds, underdrained by tile pipes, covered with medium sized stone, with a top dressing of medium and fine ashes about five inches in depth. During its passage through the pipes a deodorant is added. Chloride of lime was first used, but owing to the difficulty of application, owing to the clogging of the pipes, a creosote was tried, which by emulsifying gave a more equal application, and gave good results as was testified by the absence to a greater extent of any objectionable odor.

Bacteria Beds

After leaving the tanks, the sewage passes through channels in the bacteria bed room onto the beds, and here the problem is to find a system which will distribute the sewage over all the beds evenly, so that they all perform an equal amount of work. Stoddart's trays were first installed, but although they have proved successful as small units of four or five trays, the size of the beds necessitated the use of too many trays to ensure their being level, and after many attempts to level them, which proved failures, they were taken out, as portions of the bed got all the sewage and the rest none or very little. The rectangular system of travelling distributors was then installed, and after many experiments they have proved successful in the matter of even distribution. We have found it necessary to grease the rails in order to keep moisture from them, as rust is soon formed on a dry rail, and retards the running of the machines. After the rails have been treated a few times liberally, the application of a small portion here and there on the rail is sufficient to keep it in good condition. Ordinary axle grease was first used, but it was found to become gritty, and hard oil is now being used with success. As with other machinery, the distributors require constant attention to keep them efficient. The application of an anti-acid paint is necessary to prevent or to retard the corrosion of the buckets, as we find that the action of the sewage soon causes corrosion, and the replacing of the buckets is an expensive item.

In the November 28th issue there appeared a paper by S. Svenningson on the transmission line across the St. Lawrence River. During a change in the arrangement of the reading portion of the issue, a footnote stating that this paper had been presented the previous Friday evening at the University of Toronto to the members of the American Institute of Electrical Engineers, was accidentally and unintentionally left out. An editorial referred to the discussion of Mr. Svenningson's paper by the members of the A.I.E.E. A brief abstract of the paper had previously been printed by the A.I.E.E., but the article in the Nov. 28th issue was the first publication of Mr. Svenningson's complete paper, with original illustrations.

PROGRESS, PROSPECTS AND PITFALLS OF THE NEW PROFESSION OF CITY MANAGER*

By O. E. Carr
City Manager, Springfield, O.

IT is now eight years since the city of Lockport, N.Y., became interested in the new form of government which she called the Lockport plan. But Lockport did not originate the plan,—it came directly from the minds of men who were studying municipal matters. Briefly the plan of the theorist was:—

1. To throw municipal government into a single elective body.

2. To place the number of commissioners at five, this being considered to constitute a workable and logical number designed to form the legislative body of the city.

3. To embody in the plan the principles of initiative and referendum and recall.

4. To arrange that a manager be appointed who should constitute the executive head of the city.

The Lockport Bill

The Lockport Board of Trade sought to have the New York Legislature pass a bill enabling any third class city in the state to be governed by this form of government. The bill failed. It was in advance of the thought of the legislature. That was a short 8 years ago. Such a law was passed in New York in 1914. Lockport business men are just now embarking on a second attempt to secure the city manager plan for Lockport.

Since we met last year a decisive year of the world's history has passed (never a year of such stupendous undertakings). Naturally it would tend to restrain small movements like that of changing the system of local governments.

But the movements of government are bound up in the world movement, material progress has not been so rapid but the idea itself has been immeasurably advanced by the great war. Last May our secretary reported 123 cities committed to the city manager plan. Not a single charter city has yet gone back to a former plan of government. But best of all we chronicle a change in the attitude of the public mind towards the plan. When we last met rural communities were debating the commission manager plan. City high schools were working upon it. It was considered a debatable question with much to be said upon both sides, but since the immersion of the country in the great war our national thought has been clarified and purified in the determination to succeed fully in the overthrow of our enemy. We have tried Committees, Boards and Groups. It was our usual way of working. But we were forced to discard them and place the responsibility in a single executive head. Never has there been such an innovation in the government. One after another the great Boards that were to accomplish so much, were put in the discard. At present Ryan and Schwab, single executive heads in the air craft and ship building, are accomplishing what we hoped to in the beginning.

Public Not Hostile

We need argue no more; proof is before us; the public has been taught by heart breaking lessons, for this time we have the minds of the public at large turned towards the principles of the plan, at least without hostility.

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*Abstracted from paper read before Fifth Annual City Managers' Convention.

But the thought of the public at large has changed no more than the thought of the managers themselves. We have come a long way from the atmosphere of our first meeting. Then we were men upon whose shoulders fell responsibility for good government and good morals, for development and proper growth, for settling immense problems for the city we served. We had, to put it mildly, a large sense of the community's need of us and of what we individually contributed to our various communities. None of us managers in those days were inclined to underrate ourselves. You remember that early feeling on the part of the citizens in which the majority of managers acquiesced was, that the manager was not only responsible for the administration of municipal matters but that he was also responsible for the direction of thought of his community and its activities in every line. In other words, that he was a sort of superman (many sided and versatile), the leader of his community and a man to be consulted in every venture. Now, of course, the manager as a public spirited citizen, is and should be interested in all things which make for the betterment of community life, but he has one duty—the administrative details of his city. He is not the only competent man in his community nor is he the only thinker. The most successful government is the one which is able to secure the most interested service from its citizens. Certainly the manager should not attempt to do all of the work pertaining to the growth of the city. I was aware that there have been different practices along this line. Some managers have been very loath to allow even a community activity like the Red Cross or War Chest to operate without themselves taking the reins by means of some high place. In every way possible they have sought to keep their hands on every activity in the city. Can we doubt that because they are mere men, and not at all super, that they have neglected duties essentially their own and they have dissipated their energies in directions which should be managed by other citizens? There is no doubt that logically speaking such a many sided manager might do real harm in the community. His activity in all public questions would result in a like passivity on the part of citizens trained and qualified for just such prominence.

Should Not Agitate Municipal Ownership

An illustration to make this point clear. It is the duty of a manager to obtain the best service at a reasonable rate from a public service corporation. Suppose that he fails in his attempt to secure creditable service; then it is his duty to go before his commissioners and his public with facts and figures to prove to them concretely that the corporation is not rendering adequate service nor service equal to the amount of money expended for it. It is not his duty, as I see it, to agitate therefore for municipal ownership of such public utility. This should be left to the commission or should be taken up by the Chamber of Commerce or various city clubs. It is obvious since efficiently operated public utilities are their own best argument for municipal possession the manager should expend every energy towards giving service from those already possessed by the city since this is his direct duty.

By this attempt to standardize, in a measure, the duties of a manager we are attempting to increase his efficiency in the exercise of them. Our managers were men from other professions who carried to the new field no wealth of experience. They cannot do well the work for which they are directly responsible if they assume the direction of all activities within the city.

If we have saved money, conserved health, contributed to the growth and well being of our community in large contrast to previous government, it is not due so much to our personal ability as it is to a form of government the principles of which are easy in operation and the responsibilities of which are definitely fixed thereby making success a natural consequence.

Prospects of Commission Manager Form

During the past year every effort of our citizens has been directed in various activities in connection with winning the great war. The drawing of municipal charters has for the most part been given up until our victory is finally won. But it must not be forgotten that those activities of war have trained a body of citizens in putting over public enterprises. Four-Minute-Men, Liberty Loan and War Chest workers are going to become interested in whatever is necessary in their communities. On account of the training they have received they are going to make short work of educating the public to new ideals of government. Moreover as stated before, this public mind will have no difficulty in meeting the ideals of the commission manager plan. The march of the human mind is slow ordinarily but there never was a time when the people at large will so accept the plans of a new government as now. There is positive pre-disposition towards it. Not in vain have been our great public failures in connection with our air craft, shipping and ordnance boards. Not only does the public see that a single head is necessary for a department but it sees that that head must have had specialized training in the department and line which he heads. This lesson has cost us the lives of many of the boys we have lost on the other side.

The cities under the commission manager plan have moved along, adapting themselves to increased expenditure without increased revenues. Not one of them has gone back to the old charter form. In a very few of them old politicians have taken the public unawares and are back in power. I cannot prophesy just how that condition will end for even when politically administered the city manager plan shows good results simply because it fixes individual responsibility and there are many ways by which a public official in these days may be made to act. Altogether the future looks very bright for the Commission Manager plan.

Obstacles in the Way of the New Profession

This part of the subject brings to my mind the query as to whether our work has as yet risen to the dignity of a profession. Can we say as yet that it is work which requires a specialized training We are not even yet arrived at a point where we can settle the matter of suitable training absolutely definitely.

There is every indication that we have a new profession in city managership. At least a number of us have gained our experience in one place and have been promoted on account of our experience to others. But I do not believe that a City Manager will become a permanent fixture in his community, nor do I believe that it would be desirable except in very exceptional cases. Our school superintendents meet this same condition. We are practically agreed that our schools are benefited greatly by an occasional exchange of executives. The infusion of fresh ideas, new plans and different methods in a community benefits it and keeps the ruts from forming. It

(Concluded on page 519.)

CONTROL OF STREAM POLLUTION*

By Prof. Earle B. Phelps
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THIS is a day and age of conservation. The natural resources of our country, once seemingly inexhaustible, are to-day being catalogued and apportioned. Agencies and possibilities, hitherto untouched because of the superabundance of cheaper agencies and more ready possibilities, are now being husbanded and developed. Among the greatest of these is water.

The control of stream pollution rests upon the common law rule of riparian rights, re-inforced in certain cases by state legislation. Under the common law, in theory at least, a riparian proprietor is entitled to have the water of a stream flow past his land in its natural state and quantity. It is clear, however, that a strict and literal interpretation of this rule would defeat its own purpose, since almost any beneficial use of the water will to some extent alter its quality and quantity or both. Hence the usual interpretation of the common law makes the right of a riparian owner subject to any reasonable use of the water by an upper proprietor.

This extension of the rule places the whole matter upon a determination of facts as to what constitutes a "reasonable" use.

The reasonableness of a use is naturally difficult of exact determination. It varies with each situation, being dependent upon many factors such as local custom, long established practice, necessity, and, even in some cases, the relative value to the public of the interests involved.

Use of Streams for Waste Disposal

Streams, lakes and other bodies of water constitute the natural vehicle for carrying off the wastes, especially the liquid wastes, of the tributary watershed. In a state of nature they receive the surface drainage of the land and under conditions of modern city development this is facilitated by the provision of artificial structures, pavements, drains and sewers. In nature this drainage contains polluting materials, soil-wash and the debris and wastes of animal and plant life. The concentrated drainage of the community contains likewise the wastes of the community, street washings, the waste waters of the industries and city sewage.

Such a use of streams, therefore, is in the broad sense a natural use, the development of a normal and natural process. Were there no alternative, no possibility of interposing between the stream and the source of the pollution some remedial treatment, then this use of streams to carry off community wastes would be a reasonable use, because an unavoidable one. This conception of reasonableness is important because, as will be shown, in the case of conflicting or incompatible uses of a stream, the reasonableness of each use will be determined to a large extent by its necessity to the welfare of the community.

The use of a stream to carry off the wastes of a community also represents a natural resource of great value, and one not to be likely interfered with or restricted. Such a use is proper and advantageous just so long as it may be employed without trespassing upon other equally proper and important uses. It becomes unreasonable and subject to restrictive measures just as soon as it seriously encroaches upon or curtails other uses of equal or greater importance.

Effect of Stream Pollution

Many and diverse are the effects of stream pollution. It is customary and convenient to group them into three groups or types, corresponding to the three general characteristics of sewage and wastes, the bacterial, the physical, and the chemical.

Bacterial pollution, especially that of a dangerous sort, has its origin primarily in sewage. Its most serious aspect is the transmission of water-borne infectious diseases. From the point of view of stream injury, therefore, its result is to render a stream unfit for water supply without adequate purification, and, if sufficiently concentrated, to impose an undue burden and responsibility upon a water purification plant.

In addition to its effect upon city water supply, bacterial pollution affects the public health in other ways, particularly in the matter of bathing beaches and shellfish areas.

The physical aspects of pollution appear next in order of development with increasing pollution. They result from the physical properties of the waste and the effects of certain industrial wastes are often much more serious than those of city sewage. They include discoloration and turbid appearance of the water, floating scums of oil and grease, unsightly deposits upon the shores and bottoms, and, in extreme cases, accumulations of sludge injurious to navigation or mill-power interests. The use of the water for boating and pleasurable enjoyment is interfered with and there is probably some effect upon fish life. The damage resulting from physical injury is largely a property damage and its control a matter of economics.

With still greater pollution loads a stream ultimately breaks down chemically and changes rather abruptly from a polluted stream to an open sewer. This effect is the result of the organic and putrescible character of the polluting matter. Normally a stream holds in solution a certain proportion of the atmospheric gases, oxygen, and nitrogen. Minor organic pollution undergoes a normal process of decay and oxidation in the stream similar to that which occurs in the soil, except that, because of the great dilution and excess of oxygen, the process does not become putrefactive or objectionable. The partial depletion of dissolved oxygen in the water is quickly made up by absorption from the air, and the limit of the power of re-aeration measures the capacity of the stream to carry on the work of oxidation. If the demands upon the stream exceed this capacity, the entire nature of the biochemical processes taking place is altered, and offensive putrefactive conditions obtain.

Temperature, Depth and Velocity

Two important effects of this principle should be noted. With increasing temperature bio-chemical oxidation takes place more rapidly, while the rate of re-aeration of water decreases. Consequently, with an increasing pollution load, a stream first breaks down during hot weather, becoming normal again in cold weather. The second effect is that depth and quiescence are unfavorable to re-aeration, while shallow turbulence is most favorable. It follows, therefore, that a shallow, turbulent or swiftly running stretch of stream may remain in a reasonably normal condition of aeration long after another stretch of the same stream, in a deep quiescent pool behind a milldam has become exceedingly offensive. In the absence of more exact chemical tests, the approach of over-

*From one of the "J. E. Aldred Lectures on Engineering Practice" at Johns Hopkins University, 1918.

loading of a stream may first be discerned during warm weather and in the stagnant reaches.

The results of excessive chemical pollution are malodorous conditions, putrefaction upon the bottom with accompanying evolution of gas, destruction of all fish life, and blackening of white lead paint upon boats. It is the last stage of pollution. The natural stream has been destroyed, a sewer created.

Self-Purification of Streams

A consideration of the first importance in any discussion of stream pollution is the principle of self-purification of streams. It involves the workings of many factors and forces which together bring about a result quite similar to that observed in the better known phenomenon of decay and decomposition in the soil. The activity of the soil in assimilating and ultimately disposing of organic material is well known. By a process of oxidation, brought about by micro-organism, decomposible organic matter is quickly rendered innocuous and indistinguishable from the soil itself. The essential factors are, organic matter capable of oxidation, the necessary micro-organisms and oxygen.

In streams the same phenomenon takes place at a much more rapid rate, water being a great accelerator of chemical reactions.

The primary factors are again, decomposible organic matter, micro-organisms and oxygen. In this case there are secondary factors also at work, the chief of them being mere mechanical dilution in greater volume of water, and sedimentation. These, however, are apparent rather than real agencies. The one obscures the effects of pollution, the other removes the action from the immediate field of observation. As is true in most chemical reactions, the element of time is an important one and herein lies the apparent distinction between the self-purifying powers of rapidly running and of nearly quiescent streams. Self-purification is actually facilitated by the aeration which accompanies rapid movement. Movement also hinders the sedimentation of material upon the bottom, where its subsequent oxidation may be retarded by lack of oxygen. But the more rapidly moving stream travels a given distance in less time, so that the degree of completion of the reaction at a lower point is actually much less. It happens, therefore, that for conditions of moderate pollution, where the possibility of actual exhaustion of oxygen is not a controlling factor, and this condition generally maintains in drinking water streams, a quiescent stream with long time of passage and opportunity for effective sedimentation provides the optimum condition for the improvemnt of the water between a source of pollution and any fixed point below. On the other hand, for cases of more intense pollution, oxygen supply controls and a condition of de-aeration and of foulness and physical nuisance may often result in a sluggish or stagnant stream, while the same stream with the same degree of pollution could maintain itself in apparently good condition were it in rapid and turbulent motion at all times.

Time is Essential Factor

Bacterial self-purification follows similar laws, time being the essential factor, and dilution and sedimentation important associated factors. In this case, however, quiescence is generally advantageous since bacterial pollution and self-purification are of interest only in cases of streams that are suitable for water supply and such streams do not as a rule ever approach an anaerobic condition. Moreover, oxygen is less essential in this case, since destruction of bacteria in a stream is due to natural biological causes rather than to chemical oxidation.

Sewage Treatment

Sewage treatment has been developed along various lines, which may be classed for convenience of discussion into mechanical, chemical and biological. A complete project, however, may comprise works of two or of all three sorts.

Mechanical treatment includes screening and sedimentation of sewage and pressing, drying and other like operations upon sewage sludge. Screening effects the removal of a portion of the suspended solids and becomes more efficient, and likewise more difficult and expensive with decreasing size of openings. Coarse bar screens, with openings of one inch or more, cleaned by hand, constitutes one extreme; fine mechanically cleaned screens with openings of one-sixteenth inch or less, the other.

Sedimentation is more effective than screening in the removal of the more finely divided material. Properly designed settling tanks will clarify sewage so that almost no further deposit of material will take place in the stream.

The mechanical removal of a greater or less proportion of the solids capable of settling constitutes the first and simplest step in stream protection and is usually a pre-requisite to more complete methods of treatment. When employed alone it tends to prevent physical nuisance, and reduces the demands upon the oxidizing capacity of the stream. It does not appreciably improve the bacterial conditions.

Chemical Methods of Sewage Treatment

Under the head of chemical methods come some of the oldest and one of the most recent methods of sewage treatment, namely chemical precipitation and chemical disinfection.

Chemical precipitation consists in the addition of a coagulant to assist in the clarification much in the same way in which an egg is employed to clarify coffee. A great variety of substances were used at one time, but in later years the process in this country has been confined to the use of sulphate of iron and lime, or of lime alone.

The sludge is precipitated in large settling tanks and submitted to further mechanical treatment such as pressing or else, as at London, disposed of by dumping at sea. The process is not an economical one in comparison with the cost and results of other processes and is now rarely if ever adopted in new projects. It gives partial clarification, with little significant removal of bacteria.

Chemical disinfection has for its primary purpose the destruction of undesirable bacteria. It is used either as a major process or in conjunction with other treatments.

Biological Treatment of Sewage

The biological treatment of sewage is merely the adaptation of the natural process of decay and oxidation which occurs in the soil and in polluted water. By suitable engineering devices the optimum conditions for the growth and activity of the requisite organisms and for bringing them into suitable contact with the sewage are provided.

The biological processes are of two major types, the anaerobic and the aerobic. In the former, the chemical changes are putrefactive in nature, and result in a liquification of much of the solid matter and consequent reduction of the sludge disposal problem, one of the most difficult matters incidental to sewage treatment. Septic and Imhoff tanks are representative of this type. In the sep-

tic tank the entire sewage flow comes under the influence of the anaerobic conditions and is rendered black, very foul, and much more difficult to treat by oxidation processes later. In the Imhoff tank the sludge settles from the sewage into a lower chamber for digestion, leaving the clarified sewage fresher and much less offensive. Both of these tank treatments combine physical sedimentation with biological digestion of the separated sludge. They clarify the sewage and are commonly used as preliminary treatments, although under certain conditions they may properly serve as major processes.

Aerobic biological treatment may be applied to crude or screened sewage or to the clarified sewage resulting from any of the preliminary processes that have been described, It includes the various forms of so-called "filtration," although this term is a misnomer. In sand filtration, sewage is applied in small intermittent doses to prepared beds of sand. With good drainage and aeration, the oxidation takes place rapidly, the process building up intensive growths of oxidizing organisms. For more rapid and less complete oxidation coarser materials and deeper layers are employed. The contact and trickling filters contain crushed stone over which the sewage flows. In the contact bed it is held for a while, the bed standing full, while in the trickling bed the process is nearly continuous except for a short intermittency to facilitate distribution by the fountain-like distributors.

The newest type of oxidation process is the co-called activated sludge or aeration process. Here filtering media for the growth of the organism are dispensed with entirely, the growth being maintained in a mass of sludge, with which an incoming stream of sewage is mixed under forced aeration. This sludge, together with additions from the sewage under treatment, is later separated by sedimentation.

In every instance the essentials of oxidation or aerobic treatment are, as in the stream, organic matter, organisms, and oxygen. A possible end product is an effluent completely oxidized, crystal clear, and with low bacterial content. For economic reasons, however, this desirable end product is seldom sought. Partial oxidation, a fair degree of stability and reasonable clarity are the more usual specifications.

The Purification of Water

The third type of protective agency, water purification, lies between the polluted stream and the water consumer. It is not strictly, therefore, a measure of stream protection, but as the whole broad question of stream control involves a consideration of reasonable uses, it is often necessary to consider the feasibility of permitting some stream pollution, providing it is within the power of properly operated works to offset the effect and prevent injury to the public health. It may be taken for granted that a stream draining populous areas cannot, with the exercise of all reasonable care, be sufficiently protected from minor pollution to be kept safe for domestic purposes without purification. Purification works are, therefore, a necessary part of the complete system and may properly be taken into account in any attempt to fix an upper limit of permissible pollution. The three major types of water purification correspond approximately to the major types of sewage treatment. The biological method, slow sand filtration, is the oldest and depends mainly upon biological activity supplemented by mechanical straining. Mechanical or rapid filtration is purely mechanical straining through sand supplemented by chemical coagulation and sedimentation. Chemical disinfection with chlorine, ozone, or other chemical agent or physical disinfection by means of ultra-violet light, are the most recent developments. By one or the other of these means, or by filtration followed by disinfection, water of a considerable degree of bacterial impurity may be rendered entirely fit and safe for human consumption. One of the important problems of the present day is the fixing, in definite terms, of the upper limit of pollution which a water filter will remedy without too serious an encroachment upon its margin of safety. It is a problem of specific rather than general solution and the desirable economic condition may be found in many cases to be somewhat below the maximum limit of water filter loading.

Summary of Present Status

A greater or less degree of pollution is inevitable and streams draining populous areas cannot be maintained in a condition fit for domestic water supply without adequate water purification.

Pollution arising from city drainage, including surface wash, industrial wastes and sewage, creates three distinct kinds of injury or nuisance, bacterial, physical and chemical. The first injures or menaces the health, and all three directly or indirectly constitute injury to property.

The situation would be intolerable were it not for the three protective agencies, the self-purification of streams, sewage treatment and water purification.

The sum total of the possible injury to the stream is determined in each case by the concentration of populations, the nature and extent of industries, and the volume and self-purifying capacity of the stream itself.

The necessary limit of permissible injury by pollution is fixed by the various uses to which the stream must be put, and, in the case of water-supply streams, by the sanitary standards for domestic water and the limitations of water purification treatments.

The control of stream pollution is at present exercised by the states, generally under the broad police powers of the public health authorities. This arrangement, while in many cases serving excellently to protect the public health, especially as affected by water supply, does not permit the development of a uniform system of stream control especially desirable in the case of the great interstate streams, nor does it tend to develop along scientific lines the maximum usefulness of the stream for diverse purposes.

The Remedy

It is rather strikingly characteristic of the problem of stream control that a careful and detailed statement of its many important aspects and their inter-relation can hardly fail to indicate a desirable course of remedial procedure.

A serious problem exists and the present method of treatment is obviously and hopelessly deficient in meeting it. No attempt is being made to develop a comprehensive and uniform policy of control nor is such an attempt likely or even possible under the present system. The waterways of the nation are a national asset, their economic development and utilization, a national problem.

Whether the question of the control of stream pollution is not so intimately bound up in the broader one of waterways control and development in general as to make it desirable to place this function in the hands of a Federal Waterways Commission with broad jurisdiction over all phases of water control may properly be left for later consideration, but the ultimate solution lies in some form of a national conservation program. There is required for the adequate control of stream pollution in the United States, a single jurisdiction, with ample authority vested

in the hands of a competent commission or other federal body.

This body should apply itself to the formulation of a comprehensive policy of stream restoration, development and control; a policy based upon a thorough scientific study of stream resources, advantageous uses, protective measures, and necessary and feasible restrictions. The development and adoption of such a policy is of greater importance than the immediate enforcement of remedies, for this work looks far into the future. It will be found necessary to mould into form the more difficult existing situations by steady, consistent but gradual pressure, protecting to the maximum, all established interests in streams, while enforcing all reasonable and feasible corrective measures.

By the early adoption and effective prosecution of such a program, the government may not only avoid the difficulties and losses that inevitably result from neglect of remedial treatment until industrial and municipal developments are well established, but in the end will have effected an enormous conservation of the vital capital of the nation.

KEEP THE MAIN ROADS OPEN IN WINTER*

By Geo. H. Biles
Second Deputy State Highway Commission, Pennsylvania

OUR state was put to the crucial test last winter in answering the call of the nation to keep the roads open. I dare say that few of us recall a more severe winter and it augurs well for the future when such abnormal conditions can be successfully combated as was the case with our main arteries of traffic. The first steps taken to cope with the situation were to provide an organization to prosecute the task efficiently. This was but an enlargement of the regular force of maintenance employees. I might mention here that we have a colossal maintenance proposition in Pennsylvania in looking after the upkeep of over 10,000 miles of highways, approximately 65% of which are unimproved, and with a working force in some periods of the season of over 12,000 men, it must be granted modern business principles in organization and operation are essential.

The Division of Maintenance of the Department composed of the Assistant Engineers, Superintendents, Foremen, Caretakers, Labor, etc., took complete charge of the snow removal work under the direct supervision of the Second Deputy Commissioner. From the inception of this Division in 1913, surveys and studies have been made of snow conditions and data compiled that has and will continue to serve in good stead, for there are many points where it has been developed that the construction of snow fence is the most economic practice. Considerable of this snow fence has been constructed up to the present time and is ready to be put in place. At present prices, this costs approximately 50c. per running foot in place and the design closely approximates the railroad standards.

Snow removal work from the experience of the speaker resolves itself into snow fighting from the time the first snow makes its appearance. Work begins when heavy falls come by breaking through a track with road drags or small "V" shaped plows drawn by teams. These are followed by the road machines or motor trucks with the snow plow attachments. Turnouts are made at convenient intervals and as soon as possible thereafter the road opened to the desired width of from fourteen to eighteen feet depending upon the traffic. On improved roads every effort is made to remove the snow within a few inches of the metal of the road, in order that no opportunity is given the traffic to track. What snow remains that does not melt, is removed entirely.

Rolling Sometimes Suffices

I will qualify remarks just made by saying that these methods apply particularly to improved roads, for if traffic is permitted to track during periods of freezing and thawing on such highways, the surface becomes affected to various degrees depending on the type of the road. We have a number of miles of waterbound macadam roads with bituminous surface treatments on the main trunk lines, and in order to preserve them during such periods it is essential to distribute the traffic. On the unimproved roads the snow is not taken off entirely down to the surface, but several inches is left remaining for the travel to pack, and as it softens more snow is dragged from the sides, in order to keep the surface comparatively smooth at all times. Rolling of snow is done on the lesser important lines, but this has not been very satisfactory on the roads where there is much motor traffic, on account of the rough condition that results when the surface becomes cut up. The snow being rolled and wet from time to time with sleet and rainstorms, becomes almost as hard as ice. However, there are a number of roads where the travel is light and used mostly by horse-drawn vehicles, where this method will suffice.

In the work just described, especial attention was given to the drainage and cuts were made through the banks of snow to the ditch lines at certain intervals where possible and drains and culverts kept open and free from obstruction. This precautionary measure produced very good results, for when the snow passed away in the spring, the roads had come through the winter in better shape than they had any previous time, in spite of the fact that they had been subjected to greater traffic and increased weight of loads.

Special Treatment for Heavy Drifts

The heavy drifted condition required especial treatment. Drifts were so deep and banks so high on either side of the road in some places that snow had to be shoveled and hauled out. Snows up to twelve inches in depth can be handled advantageously with road machines, and from twelve to thirty-six inches, if not too heavy, can be moved with motor trucks with plow attachments, with excellent results. The truck is run along the one side of the highway and back on the opposite side at the rate of about four miles per hour and carries a small crew of men with shovels that are used when the snow piles up in front of the blade, which it will do especially when the snow is wet. When there is a greater depth than three feet, a large "A" shaped plow is used. This implement is 30 inches high at the nose and 6 feet at the back with 20 ft. legs and 16 feet wide at the back, held together with movable braces and drawn by a heavy tractor, and it has proven a very economical and effective device. The movable braces are provided for the purpose of permitting vehicles to pass during the operation, if necessary. The light tractors for his work do not hold the road and have been found unsatisfactory. Mechanical devices are preferable in the majority of cases but if the drifting is a continuous performance in cuts, it resolves itself into a shoveling proposition.

*Abstracted from paper read before the recent Conference on "Snow Removal from Trunk Highways." held in New York City.

To keep the roads open under conditions similar to last winter, it costs from $50.00 to $200.00 per mile, depending upon the location and other conditions,

In 1912 when our system of roads was taken over for maintenance, the highway laws with respect to keeping up the road were not generally interpreted to mean that snow should be removed, for it was an uncommon thing for the local road officials prior to this time to open the drifts. In many places, the fences along the line of the highways were removed and the fields used until the snow passed away. If the thaws caused the fields to become soft, in which condition the traffic would do them considerable injury, in such cases some effort was made to make the roadway passable. This era quickly passed and with the changing and increased traffic, the demands became great for an open highway the year around and in 1913 this responsibility was assumed by the State Highway Department and practically all the main trunk lines were kept open from this time on. The records for the winter of 1917-18, which covered the period from December to March show 22 snowstorms varying in depth up to 16", with drifts ranging from 3 feet to 16 feet in depth, the general average being 4 to 6 feet.

I firmly believe that where statutes permit, and if they do not, the legislative bodies should pass enabling measures at once, it should be no longer an optional matter with the road officials in charge of our highways, for when we consider the enormous winter traffic on some of our roads argument is unnecessary. As an example, we have a case on record of one of our highways when the temperature was down to 25 degrees below zero, and from actual traffic census it showed that over two thousand vehicles passed over the road in twelve hours, the answer is that it is no longer a theory.

PROGRESS, PROSPECTS AND PITFALLS OF THE NEW PROFESSION OF CITY MANAGER

(Continued from page 514.)

will be so with the managers. A conscientious manager will be popular one month and unpopular the next. It is but a matter of time when he will have offended a considerable number of citizens by not seeing just their way in matters which if undertaken, would have benefited each of them materially. The ungratified citizen becomes a publicity man against the manager and the harm he is able to do will be in proportion to the friends he has in the community. Therefore, the time will come in the history of each manager just as in the case of superintendents of schools when his best field for effort will be in a new locality.

Small communities are sometimes apt to think the salary asked by an experienced man is excessive, so they will select a young man who may or may not be a good manager material, or a man who has served in various other political offices. Of course I must discuss the matter as it appeals to me. Many professions have been called upon in the emergency to furnish managers. Some cities have sought the usual politicians. This is pitfall number one.

I can see why the engineering profession has been called upon so extensively to furnish managers. I can see why expert financial ability is an asset, why general publicity work might operate to advantage, why Chamber of Commerce men might do good work, but I will never be able to see why a perfectly good, honest plan of government should be prostituted by the appointment of a man accustomed to judge by political ideals. Human beings cannot help being products of their environment. Especially is this true of the moral senses. A politician will not administer government save as it makes for his own selfish ends. He cannot see further than that. Some of our cities which started right, have been manipulated so as to allow a politician to become a manager thereby discrediting the plan.

A second danger lies in the mere human quality of managers. Power is a hard thing for a human being to stand. A manager must curb his tendency to high handedness, bull headedness or whatever name you may give the quality. Some prominent public officials have not been proof against this trait. I have no doubt that several managers have rendered their usefulness negative by just such a development. It has certainly caused some dismissals.

PUBLICATIONS RECEIVED

Steam Turbo-Electric Stations.—Bulletin issued by the Bureau of Mines, Department of the Interior, Washington, D.C., on the economic operation of steam-turbo-electric stations, by C. T. Hirshfeld and C. L. Karr. Thirty pages, 6" x 9", 5 diagrams. Discusses factors determining fuel economy, distribution of load between main units, boiler room operation and operation of auxiliaries, and contains a bibliography on the utilization of coal and lignite.

Fuel Economy in the United States.—A reprint of article appearing in "Engineering" of London, England, August 23rd issue, by D. Brownlie, B.Sc., F.C.S. Eight pages and cover, 7" x 10", issued by Brownlie and Green Ltd., Church St., Cheetham, Manchester, England.

Engineering Practice.—Published by the Department of Engineering, Johns Hopkins University, Baltimore, Md. Price, $1.00 per copy. 236 pages and cover, 6" x 9", containing a number of illustrations and three plates. Through the generosity of J. E. Aldred, there was founded at the Johns Hopkins University, about a year ago, a course of lectures dealing with the practical phases of engineering problems. These lectures do not presuppose an extensive knowledge of underlying theory, but lay stress on the tangible and obvious features of present engineering methods. During the past season, which was the first year of these lectures, there were three lectures on civil engineering subjects and three on electrical, while an equal number dealt with mechanical engineering, making nine lectures in all. One lecture was by a Canadian engineer, Julian C. Smith, vice-president of the Shawinigan Water and Power Co., whose address was on the "Growth of Electric Systems." An abstract of Mr. Smith's paper will be published in an early issue of *The Canadian Engineer* and possibly also parts of some of the other papers. The other lectures were as follows:—"Steam-Electric Power Plant Design," by A. S. Loizeaux; "The Relation Between Civil Engineering and Military Engineering," by Major General William M. Black; "The Development of Concrete Road Construction," by Arthur N. Johnson; "Copper Refining," by Edwin Wells Rouse, Jr.; "The Coal Problem," by E. G. Bailey; "The Operation of a Manufacturing Plant," by Ralph E. Thompson; "The Control of Stream Pollution," by Earle B. Phelps; and "The Manufacture of structural Steel," by Bradlay Stoughton.

ELECTRIC POWER GENERATION IN ONTARIO ON SYSTEMS OF HYDRO-ELECTRIC POWER COMMISSION*

By Arthur H. Hull

THE Province of Ontario is the largest and most populous of the Provinces in the Dominion of Canada, having an area of 407,262 square miles and a population (census 1911) of 2,523,274. Ontario's population is about 35 per cent. of the total of Canada's population, and its area is 10.9 per cent. of the total area of the Dominion. Ten per cent. of its area is water.

Ontario has developed into the greatest manufacturing province in Canada and as there are no coal deposits in the province, its abundant power resources are being more and more utilized to furnish the power required for its varied and increasing industrial development. Other fuels, such as natural gas and petroleum, are found in the southern part of the province, gas along the north shore of Lake Erie and petroleum near Sarnia. The natural gas supply, however, is insufficient for present purposes and the quantity of petroleum produced does not begin to meet the needs of the province. The demand for electric power has increased during the past ten years to such an extent, that, with the war industries in operation, it became necessary to impose restrictions on private and municipal consumers in order to provide the power required by the war industries. The great saving in coal effected by the use of electric power in Ontario's industries is one of the most important aspects of the electric power situation, and further, great savings can be, and will be before long, brought about by the electrification of the steam railroads.

Mr. H. G. Acres, in a monograph on water powers of the Province of Ontario, written in 1915, gives the following summation of water power capable of development, and of water power already developed in the province.

Division.	Potentiality. h.p.	Developed. h.p.
Ottawa River and Tributaries ..	688,000	71,000
Great Lakes Tributaries	446,000	137,000
Hudson Bay Slope	250,000	22,000
James Bay Slope	1,500,000	70,000
International Boundary Rivers ..	2,045,000	462,000
	4,929,000	702,000

Of the above total for power developed, about 69,000 horse power is used in pulp and paper manufacture, about 59,000 horse power is used as hydraulic power directly applied, and the balance 574,000 horse power is converted into electric energy for light and power.

This paper will deal only with the generation of electric power by the Hydro-Electric Power Commission of Ontario, which is now the largest producer and distributor of electric energy in the province.

The Hydro-Electric Power Commission of Ontario, which will be referred to hereafter as the Commission, was formed by the Ontario Government in 1906, and first furnished power over its 110,000-volt lines from Niagara Falls in October, 1910, the power being purchased from the Ontario Power Company of Niagara Falls, Ontario. It was not until August 1st, 1917, that the Commission obtained direct control of the generation of power at Niagara Falls, through the Ontario Power Company, but in other parts of the province, the Commission had started to develop its own power by constructing a hydro-electric plant at Eugenia Falls on the Beaver River near Flesherton, which was put into operation in November, 1915, and one at Wasdell's Falls on the Severn River which was started in service in October, 1914. In 1914 the Commission acquired by purchase the Simcoe Railway and Power Company, whose generating station at Big Chute on the Severn River had previously supplied power under contract to the Commission's Severn System, supplying the district around the southern part of Georgian Bay. In March, 1916, the Government of Ontario purchased the entire holdings of the Electric Power Company which, through subsidiary companies, was generating power on the South River near Nipissing, on the Otonabee River at Peterboro, and on Trent River at Healy Falls, Frankford, Campbellford, and Trenton. The operation of the equipments thus acquired was placed in charge of the Commission in June, 1916.

The various areas in the province served by the Commission are designated by systems as follows:—

System	Main transmission voltage	Frequency	Phase
Port Arthur System	22,000	60	3
Nipissing System	22,000	60	3
Muskoka System	22,000	60	3
Wasdell's Falls System ..	22,000	60	3
Severn System	22,000	60	3
Eugenia System	22,000	60	3
Central Ontario System ..	44,000	60	3
St. Lawrence System	26,400	60	3
Rideau System	25,700	60	3
Niagara System	110,000	25	3

Port Arthur System

In the Port Arthur System, power is purchased at 22,000 volts, three phase, 60 cycles, from the Kaministiquia Power Co., and is delivered to the city of Port Arthur at 22,000 and at 2,200 volts, part being transformed in the Commission's transforming station at Port Arthur, containing two banks of transformers, each consisting of three 750-kv-a. units connected star-delta with neutral ungrounded.

The first delivery of power was made on December 21st, 1910. The demand has been steadily increasing and in order to take care of the future requirements, the Commission now propose to construct a hydro-electric station on the Nipigon River at Cameron's Pool, about 80 miles from Port Arthur, which will have an ultimate capacity of about 50,000 horse power. The engineering work is now under way for this development. It is proposed to transmit the power at 110,000 volts, three phase, 60 cycles, to Port Arthur. Three other power sites on this same river, when developed, will, together with the Cameron's Pool site, give a total of 150,000 horse power. The needs of the Port Arthur district should, therefore, be amply provided for, but if additional power should be required for this district, another site is capable of development at Silver Falls on the Kaministiquia River about 25 miles from Fort William where with a 350-ft. head a total of 25,000 horse power can be developed. At the present time the electric energy supplied at Port Arthur is used for operation of the street railway, for public and domestic lighting, and for large grain elevators, ship yards, coal docks and miscellaneous industrial purposes.

Nipissing System

The Nipissing System, formerly controlled by the Nipissing Power Company, comprises a generating sta-

*Paper read last month before the Toronto Section of the American Institute of Electrical Engineers.

tion on the South River near Nipissing village, sub-stations in Callander, Powassan and North Bay. The transmission system comprises 26.5 miles of 22,000 volt, three-phase, circuit on wooden poles. The generating station contains two 450-kw., three-phase, 2,200-volt., 60-cycle, 450 rev. per min., horizontal generators with 12.5-kw., 125-volt direct-connected exciters, each unit direct coupled to a water wheel of 925 b.h.p. at 86 ft. head. A 27.5-kw., 125-volt, motor-driven exciter is also provided. Three 300-kv-a., 2,200/22,000 volt, single phase, water-cooled transformers connected delta-delta are installed, with one 22,000-volt out-going feeder.

Water for this plant is taken from the South River through an open canal 900 ft. long, then through a wood stave pipe 6 ft. diameter, 2,300 ft. long to a differential surge tank 72.5 feet high, close to the power house, a steel penstock connecting thence to the turbines. The storage pond has an area of about 100 acres and the drainage area of the river is about 350 square miles.

Provision was made for extension, and by additional storage works, it is possible to increase the capacity to 2,500 horse power.

Muskoka System

The power house on the south branch of the Muskoka River at Muskoka Village was formerly owned by the municipality of Gravenhurst and was taken over by the Commission in the latter part of 1915, and has been remodelled and enlarged, and now supplies power over a single circuit 22,000-volt, three phase, 60 cycle line about 26 miles long to Huntsville, and at 6,600 volts, three phase, 60 cycles, to the municipality of Gravenhurst over the municipality's line.

The equipment in this station now comprises one 450-kv-a., three phase, 6,600-volt, 720-rev. per min., 60-cycle generator, direct connected to a 500 b.h.p. turbine; one 750-kv-a. similar 720-rev. per min. generator, direct connected to a 1,000 b.h.p. turbine; one bank of three 400-kv-a., 6,600/22,000-volt transformers connected delta-delta; double low-tension bus, and single high-tension bus. Four outgoing 6,600-volt feeders are provided, two feeding to Gravenhurst and two for future use. One 22,000-volt feeder leaves the station to supply Huntsville. Provision is made in the existing building for a second high-tension feeder.

When this station was taken over by the Commission, only one 450-kv-a. generator was installed. The station was remodelled and enlarged for the larger unit mentioned above, and provision was made for the extension of the building at a future date and for the replacing of existing units so that, when future load conditions require it, there will ultimately be three 1,500-kv-a. generators with a turbine capacity of 6,000 horse power installed.

The present excitation at this plant is provided by a turbine-driven exciter for the 450-kv-a. unit, a motor-driven exciter for the 750-kv-a. unit, which also has a belted exciter for emergency use, which is so arranged that it may excite either generator.

The hydraulic head at this plant is 102 ft. The water is conducted through one steel and one wood stave pipe, each 946 ft. long to the turbines.

Wasdell's Falls System

The system comprises a hydraulic generating station on the Severn River at Wasdell's Falls near Severn Bridge, and sub-stations at Beaverton and Cannington. Power is transmitted to Beaverton and Cannington over a single-circuit, steel-conductor line at 22,000 volts, three phase, 60 cycles, and over a single circuit aluminum tie line at the same voltage to the Commission's Severn System, connecting at Longford with the town of Orillia 22,000-volt lines from Longford via Orillia to the Big Chute generating station.

The generating station which was constructed by the Commission in 1914 is interesting on account of the low hydraulic head. The normal head is 12 ft., but variations from 9 to 15 ft. occur. The equipment consists of two 400-kv-a., 90-rev. per min., vertical type, 60 cycles, three-phase, 2,300-volt generators connected through flexible couplings to turbines rated at 600 horse power at 100 per cent. gate opening with 12-ft. head. Two exciters, one 20-kw. turbine-driven, and one 30-kw. motor-driven are provided. Two banks of transformers, each consisting of three 2,200/22,000-volt, 150-kv-a. units connected delta-delta are installed. Two outgoing 22,000-volt lines were provided.

There are in this system, 37 miles of 22,000-volt circuit and 23 miles of 4,000-volt circuits from the two sub-stations.

Severn System

This system comprises a hydraulic generating station on Severn River at Big Chute with sub-stations as shown in the diagram.

The generating station as originally built in 1909 by the Simcoe Railway and Power Company contained three 900-kv-a., three-phase, 2,200-volt, 60-cycle, 300-rev. per min., horizontal-shaft generators direct connected to turbines each rated at 1,300 horse power under 56-ft. head; two 100-kw. 580-rev. per min., 125-volt exciters direct connected to 200-h.p. turbines; two transformer banks each consisting of three 600-kv-a., 2,200/25,000-volt water-cooled transformers connected delta-delta, with two outgoing 25,000-volt lines. An extension to the building has been made by the Commission during the past year, and there is now being installed one 1,600-kv-a., three-phase, 60-cycle, 2,200 volt, 300-rev. per min. horizontal generator direct-connected to a 2,300-h.p. turbine. The switching equipment is being rearranged to provide a double high-tension bus for greater flexibility in operation. Space is left for a third bank of transformers, and for two future 22,000-volt line equipments. A double low-tension bus is installed. All power is transmitted at 22,000 volts, three phase, over four lines.

An interesting feature of the transmission lines of this system is the long spans across Matchedash Bay at Waubashene, one being 1,135 ft. long and one 858 ft. long. The west shore tower is 175 ft. high, the middle and east shore towers are 88 ft. high. No. 00 B. & S. 19-strand copper conductors are used on these spans.

The water is taken from the river through a canal 500 ft. long to the head works and then through two steel penstocks 170 ft. long to the turbines.

Eugenia System

This system obtains power from a hydraulic generating station constructed by the Commission at Eugenia on the Beaver River which was placed in service in November, 1915. Extensions are now almost completed to provide double the output. This development is one of the most interesting in Ontario, and has the distinction of having with one exception, the highest hydraulic head of any plant in Canada, being 552 ft. gross. It is also one of the highest heads in the world using reaction wheels.

The first installation consisted of two 2,250-h.p. turbines each direct-connected to 1,410-kv-a., three-phase, 4,000-volt, 60 cycle, 900-rev. per min., horizontal-shaft generators having neutral grounded without resistance; one bank of three 900-kv-a., 4,000/25,000-volt transformers connected delta-delta, single high-tension and low-tension busses, two outgoing 25,000-volt feeders and two 4,000-volt feeders, one each to Markdale and Flesherton.

The extensions cover enlargement of the building to accommodate two additional generating units, one of which is now being installed, and for double high-tension and low-tension busses, and for six 25,000-volt feeders. The new unit consists of a 2,810-kv-a., three-phase, 60-cycle, 720-rev. per min. horizontal maximum-rated generator direct-connected to a 4,000-h.p. turbine. Each generator has a direct-connected 125-volt exciter of sufficient capacity to excite two generators.

The success of the development depended upon the storage of the water of the Beaver River and for this purpose two large storage dams were constructed as shown on accompanying plan. From the head works, a wood stave pipe 46 in. in diameter conducts the water 3,400 ft. to the Johnson differential surge tank which is 105 ft. high. From this tank a 52-in. diameter steel pipe is carried 1,550 ft. to the power house, which is a brick building 69 ft. wide, 112 ft. long and 34 ft. high above the generator room floor. Actual tests made at this station after the first installation was completed in 1915 gave an overall full load efficiency of 80 per cent. which shows how carefully the design was worked out.

Additional power for the Eugenia System will be obtained, when required, by the construction of further water storage systems and of a second pipe line at the Eugenia Falls development and the installation of a fourth unit, also by the construction of a station on the Saugeen River near Lake Huron which operating in parallel with the Eugenia Station will make available a total output for the system of 15,000 h.p.

The Eugenia system comprises 245 miles of 22,000-volt circuit (176 miles of lines) supplying sub-stations at the points shown on the accompanying diagram, and 50 miles of 4,000-volt circuits. This system is connected to the Severn System by means of a single-circuit, three-phase tie line from the Eugenia generating station to Collingwood, a distance of 24 miles.

By means of this tie line and the tie line from Wasdell's Falls to Big Chute mentioned above, the Eugenia, Severn, and Wasdell's systems are paralleled. The generating station of the town of Orillia on the Severn River at Swift Rapids near Big Chute is also connected into the Severn system.

Central Ontario System

Five main generating stations, one on the Otonabee River and four on the Trent River, all operating in parallel supply this system. These are now fully loaded and plans are being prepared for new stations near Campbellford to provide additional power. The five exciting stations were built by the subsidiary companies of the Electric Power Company. Immediately after the operation of this system was placed under the Commission by the Ontario Government, arrangements were made to install a new unit in the Healy Falls generating station and work on the same is now nearing completion.

The following table gives the data relative to the existing developments, all generators being three phase, 60 cycles, with 25 per cent. overload guarantees:—

Location.	River.	Gross head feet.	Units. Number. Present.	Future.	Rated capacity. Generator kv-a.	Turbine h.p.	Speed, rev. per min.	Type.	Generator voltage.
Trenton	Trent	20	4	..	937·5	1,400	120	Vertical	6,600
Frankford	Trent	18	4	..	812.5	1,200	112.5.	Vertical	6,600
Campbellford	Trent	23	5	..	750	1,100	150	Vertical	2,400
Healy Falls	Trent	76	3*	1	3,750	5,600	240	Horizontal	6,600
Auburn	Otonabee	18	3	1	625	950	150	Horizontal	2-6,600 1-2,400

*One unit now being installed.

In addition to the above stations, a 1,000-kv-a., three-phase, 60-cycle, 120-rev. per min. horizontal generator, owned by the town of Campbellford in its generating station, a short distance north of the Campbellford station, delivers its output to the 2,400-volt bus in this station. Also at Fenelon Falls, a small generating station is operated, containing two 400-kw., 600-volt, three-phase, 60-cycle, 200 rev. per min. generators connected to two 700-h.p. turbines. These feed into the 44,000-volt net work of the Central Ontario system at Lindsay, the voltage being stepped up in the generating station through two banks of transformers to 11,000 volts for transmission to Lindsay.

All these stations are on the route of the Trent Valley Canal, the dams having been constructed by the Government of the Dominion of Canada.

The Trenton station, known as Sidney Dam 2 development, being at Dam 2, section 1 of Trent Valley Canal, about one mile north of the town of Trenton, was placed in operation by the Sidney Electric Power Co. in August, 1911. The four generators feed into a single sectionalized bus, and two 6,600-volt feeders conduct the current to a transforming station across the road, which station also receives the output of the Frankford generating station at 6,600 volts. Two 75-kw. 125-volt exciter units are installed, one being a vertical turbine-driven unit and the other a motor-driven unit. Each of these exciters is capable of exciting all generators at 25 per cent. overload with 65 per cent. power factor current lagging.

The Frankford station, known as Sidney Dam 5 development, is located at Dam 5 on Section 1 of Trent Canal, about four miles north of Dam 2. This station was constructed by the Sidney Electric Power Company and placed in operation a short time after the Trenton station. It has a single unsectionalized 6,600-volt bus and its entire output is fed over two 6,600-volt circuits to the transforming station at Dam 2.

The Trenton transforming station contains three 3,000-kv-a., 6,600/44,000-volt, three-phase, 60-cycle, shell-type transformers connected delta-star with ungrounded neutral, double high-tension and low-tension busses, switching equipment for three 44,000-volt lines and for six 6,600-volt lines.

The Campbellford station, known as the Stephen's Dam Station, was first placed in operation in 1909, and is near Dam 1, Section 5 of Trent Valley Canal. This station contains four 1,125-kv-a., three-phase, core-type, 2,400/44,000-volt transformers and two outgoing 44,000 volt line equipments. Excitation for the generators is obtained from two 60-kw., 125-volt exciters, one turbine-driven and one motor-driven, with two 17½-kw. belted exciters for emergency use. The station is situated some distance below the dam, the water being conducted to it through an open head race.

The station at Healy Falls is situated about seven miles above Campbellford. Water is conducted through steel penstocks from the head gates to the turbines. A long tail race excavation through rock was necessary and

the enlargement of this tail race, necessitated by the installation of the third generator, is now being completed. This excavation work has been slow and difficult on account of the nature of the rock.

There are three 3,750-kv-a., three-phase, shell-type, 6,600/44,000-volt transformers installed, with very flexible switching equipment consisting of double 6,600-volt busses, two 44-000-volt outgoing lines, a sectionalized 44,000-volt single transfer bus, with a transformer and an outgoing line forming a unit which may be operated independent of the bus. Provision is made for a fourth generator and transformer and for two additional high-tension line equipments. Excitation is provided by two 160-kw. 125-volt exciters, one being turbine-driven and one motor-driven.

The Auburn generating station is located in the north of Peterboro, on the Otonabee River, 1,200 ft. below the Auburn Dam. Water is taken to the turbines through an open head race 1,200 ft. long paralleling the river. This station was built by the Auburn Power Co. and placed in operation in 1912 and no extensions have been made. The turbines are of the four runner type in open wheel pits 40 ft. long, 16 ft. wide and 14 ft. deep. A travelling steel gate 15 ft. 3⅜ in. by 14 ft. 3 in. is provided with motor-driven lowering and hoisting mechanism. The gate is designed to be lowered against the running water in 2½ minutes. Two 90-kw., 125-volt exciters, one being turbine-driven and one motor-driven, furnish the excitation of this plant. One generator is wound for 2,400 volts and feeds a section of the bus from which 2,400-volt feeders may be taken. This section of bus is connected to the 6,600-volt section of the bus through a bank of three 200-kv-a., 2,400/6,600-volt transformers. Feeders at 6,600 volts, three phase, connect this station to the transformer station adjacent which contains two 1,875-kv-a., three-phase, core-type, 6,600/44,000-volt transformers and one outgoing 44,000-volt line connecting into the 44,000-volt network of the Central Ontario System. Some power is also delivered to Peterboro at 6,600 volts from the generating station.

The accompanying map and diagram show respectively the location of the generating stations of the Central Ontario System, and the extent of the transmission net work with sub-stations. Other power sites along the Trent Valley Canal together with those described briefly above will, when developed, provide about 60,000 electrical h.p. with a maximum capacity of 75,000 electrical h.p. The present power output of the system is used for lighting, street railway and manufacturing purposes, a considerable quantity being required at Campbellford for a pulp and paper mill, and near Belleville for cement mills. All transmission lines are constructed on wood poles. The total mileage of 44,000-volt circuits is 372, with 15 miles of 11,000-volt circuit, 16.4 miles of 6,600-volt circuits and 52 miles of 4,000-volt circuits.

(Concluded in the next issue.)

It is regretted by *The Canadian Engineer* that Mr. Dancy's name was mentioned several times in last week's issue as H. Dancy, whereas it should have been A. H. Dancy, of the firm of H. N. Dancy & Son, Toronto. Mr. Dancy is honorary secretary of the newly-formed Association of Canadian Building and Construction Industries.

The War Trade Board announces the cancellation of the resolution prohibiting the use of steel, the value of which exceeds $2,000, in the erection of buildings and other structures. It will, therefore, no longer be necessary to obtain a permit from the board to use steel for construction purposes, however large the quantity used may be.

FEDERAL AID FOR HIGHWAYS?

FEDERAL assistance for the construction of good roads was advocated by a delegation which last Monday interviewed Sir Thomas White, Acting Prime Minister, and five other members of the Government.

It was urged that assistance be given through the provinces instead of by creating a Federal Department of Highways, in view of the necessity for early action and the likelihood that a Federal department would require considerable time for organization and might result in duplication of effort. While no specific recommendation was made, there was a suggestion that 30% of the cost of road improvements be paid by the Dominion and 70% by the province.

Sir Thomas, in view of the emphasis laid by the delegation upon the necessity for immediate action, enquired whether highway construction could be carried on during the winter. Andrew Macallum, Commissioner of Works of Ottawa, replied that much preliminary work, such as surveys and securing supplies and machinery, could be done during the winter months.

The Minister of Public Works asked whether it was the intention to abandon the idea of a national highway. S. L. Squire, president of the Canadian Good Roads Association, stated that the delegation did not advocate immediate construction of a road from coast to coast, but preferred the construction of much needed highways in the various provinces, which highways would ultimately link together to form a national route that would traverse the most populated portions of the country.

In replying, Sir Thomas White did not commit the Government to any fixed policy, but was very sympathetic with the general desires of the delegation, and stated that good roads could undoubtedly be characterized as a productive enterprise of a character in which the Dominion Government could properly take part. He referred to the appointment of C. A. Campbell, who, he said, would study the question and would probably be able to reach a conclusion at an early date.

BRITISH FORGINGS AND "THE HYDRO"

REPLYING to a number of charges recently made against the Hydro-Electric Power Commission of Ontario, Sir Adam Beck has stated that the Commission was not responsible for the establishment of the British Forgings plant at Toronto, but that the plant had been established by the Imperial Munitions Board for the purpose of utilizing the turnings from the munition plants in Toronto district, and that Sir Joseph Flavelle had approached the Commission with the request to supply the plant with 20,000 h.p.

"It was pointed out to Sir Joseph," says Sir Adam, "that the system would require the 20,000 h.p., of which it was being 'deprived' by the Ontario Power Co. As a result of misrepresentations to the government, Sir Henry Drayton was appointed power controller, although this was not what the commission had asked for After investigating the situation, Sir Henry ordered the Ontario Power Co. to go ahead with their preparations, so that the Hydro was not any better off than before.

"The Ontario Power Co. then applied for permission to use half the water-power available under the treaty, but the Victoria Park Commission refused to allow them to generate more than a total of 180,000 h.p., or 15,000 h.p. more than they were then generating. Finally, they offered to sell to the Hydro, and the offer was accepted.

"We have also been charged with agreeing to the export of 60,000 horse-power for 99 years," continued Sir Adam. "But the facts are that a binding agreement was made by the Power Co. before we secured possession of the plant, and we could not treat it as a 'scrap of paper.' We have had the term reduced by 60 years, however."

ENGINEERING INSTITUTE OF CANADA ELECTIONS AND TRANSFERS

At a meeting of the Council of the Engineering Institute of Canada, held November 26th, 1918, in Montreal, the following elections and transfers were announced:—

BARNES, ALBERT JOHNSON, of Halifax, N.S., elected associate member. Mr. Barnes graduated in 1906 from Dalhousie University and then attended the Massachusetts Institute of Technology for three years. In 1909 he entered the engineering department of the New York Telephone Co., where he remained for two years, leaving to take his present position of superintendent of traffic with the Maritime Telegraph & Telephone Co. at Halifax, N.S.

BOOKER, GEORGE ERNEST, of Halifax, N.S., elected associate member. Mr. Booker was educated in Halifax and at the University of Sheffield, England, and was for three years apprenticed as mechanical engineer with Jessop & Sons, of Sheffield. In 1907 Mr. Booker became a partner in the firm of Booker & McKechnie, Halifax, N.S.

BOWMAN, CHARLES MCCAWLEY, of Halifax, N.S., elected junior member. Mr. Bowman was born at New Glasgow, N.S., and for several years attended King's University, at Windsor, N.S. Since 1914 Mr. Bowman has been sergeant and acting machinist electrician, 10th Fortress Company, Canadian Engineers. Prior to enlisting he was associated with the Nova Scotia Road Department as rodman and leveller, and later was assistant on inspection of concrete culvert construction.

BOYLE, ANDREW JOSEPH, of Edmonton, Alta., elected associate member. Mr. Boyle was born at Antigonish, N.S., and was educated at St. Francois Xavier University. In 1911 he joined the staff of the Canadian Northern Railway as resident engineer and later as engineering inspector of stations, tanks, etc. He is at present engineer with the Department of Railways and Canals, in charge of locating parties.

CARMICHAEL, THOMAS, of Moose Jaw, Sask., elected associate member. Mr. Carmichael was born at Burntisland, Fifeshire, Scotland, where he was educated in the public schools. After coming to Canada he became draftsman to J. H. G. Russell, architect, Winnipeg, and to W. W. Blair in the office of the chief engineer, Canadian Pacific Railway, Winnipeg. Since 1917 he has been superintendent at Regina of the Works Branch of the Military Hospital Commission.

CHISHOLM, KENNETH GORDON, of Halifax, N.S., elected associate member. Mr. Chisholm was born in 1887 at Halifax and attended the Nova Scotia Technical College, graduating in 1911. In 1912 he was appointed engineer for the British Columbia Fruitlands Co., and instrument man in connection with canals, trestles, etc.; also topographical draftsman for the C.N.R. survey, Vancouver Island. From 1913 to date, except for two years in the army, Mr. Chisholm has been assistant engineer, Dominion Water Power Branch.

DONCASTER, PURCELL ELI, of New Westminster, B.C., transferred from associate member to member. Mr. Doncaster was born at Oshawa, Ont., and attended the School of Mines, Kingston, Ont. For two years he was engaged on railway surveys and later became assistant engineer with the Department of Public Works of Canada, at Toronto. From 1915 to 1917 he was with the C.E.F. in France as works officer on construction and maintenance of light railways. In 1918 he rejoined the Public Works Department as chief assistant to the district engineer at New Westminster, B.C.

JOHNSTON, KEITH PRUYN, of Saskatoon, Sask., elected associate member. Mr. Johnston was born in 1890 at Centreville, Ont. He was an honor graduate in civil and electrical engineering at Queen's University in 1912, and then for three years was lecturer in mathematics and geodetic surveying at Queen's University. He is now with Murphy & Underwood, consulting engineers, Saskatoon.

KENT, LIEUT. EDWARD SHERBURN, elected associate member, was born at Truro, N.S. Graduating at the Nova Scotia Technical College, he was for three years in charge of inspection of bridges and buildings, becoming in 1913 manager of the Western Branch of the Canadian Inspection and Testing Laboratories Co., Ltd. Since 1916 Lieut. Kent has been with the Royal Engineers in Italy.

KING, WILLIAM WHITAKER, of St. John's, Que., transferred from student to junior. Mr. King was born at Oakville, Ont., and in 1917 was an honor graduate in science at Queen's University. He was instrumentman and resident engineer on the construction of the Toronto and Hamilton Highway until he enlisted, receiving a commission as lieutenant, R.C.E.

LEAVER, CHARLES BURFOOT, of Dartmouth, N.S., elected associate member. After graduation at the University of Toronto, Mr. Leaver was employed by the Imperial Oil Co. in designing and construction work. In 1915 he became assistant superintendent of the Dartmouth Refinery.

MACNAB, SEAFORTH DUFF, of Montreal, elected associate member. Mr. MacNab was born in 1869 at Mahone Bay, N.S. In 1903 he became an assistant, and in 1908 the engineer in charge, of the Strength of Materials and Hydraulic Laboratories at McGill University.

MASSNE, HUETS, of Montreal, Que., transferred from student to associate member. Mr. Massne graduated in 1913 from Laval University. Since then he has been associated with the Quebec Streams Commission, recently as first assistant engineer on the construction of the La Loutre Dam.

MCDOUGALL, JOHN JEREMIAH, of Bell Island, Nfld., elected associate member. Mr. McDougall was born in 1887 at Glace Bay, N.S. He attended St. Francois Xavier College and then became transitman for the Dominion Coal Co. In 1905 Mr. McDougall was placed in charge of sewer, water and power plant installation for the town of Glace Bay. Since 1906 he has been associated with the Dominion Iron and Steel Co.

MESINER, JOHN S., of Dartmouth, N.S., elected associate member. Mr. Mesiner was born at Boston, Mass., and obtained his education through correspondence schools. For twenty years he has been chief engineer of the Arcadia Sugar Refining Co. at Halifax, and now is also assistant manager.

MONTAGUE, JOHN RUSSELL, of Montreal, Que., elected associate member. Mr. Montague was born in 1891 at Niagara Falls, Ont., and graduated from the University of Toronto. He was for a time employed by the Ontario Power Co. and later became associated with A. R. Henry, of Montreal, as resident and designing engineer.

ROCCHETTI, JOSEPH, of Winnipeg, Man., elected associate member. Mr. Rocchetti was born in 1879 at Fermo, Italy, and was educated at Liege, Belgium, and at the Mechanical Engineering Technical High School, Fermo. After coming to Canada in 1913 he was appointed electrical engineer with the G.T.P. Railway and three years later became designing engineer and assistant to the provincial electrical engineer, Public Works Department, Manitoba. Mr. Rocchetti was naturalized in October, 1916.

ROLAND, JOHN WILSON, of Halifax, N.S., elected member. Mr. Roland was born in 1878 at Halifax and graduated from the Massachusetts Institute of Technology in 1904. After employment in various capacities in the Panama Canal zone, in 1911 he became professor in charge of the Department of Civil Engineering at the Nova Scotia Technical College. He is at present chief engineer for Foley Bros., Welch, Stewart and Farquier, contractors.

WARREN, HECTOR DE LA GRANGE, of Pointe-au-Pic, Charlevoix, P.Q., elected associated member. Mr. Warren graduated in civil engineering at Queen's University, and also attended the Quebec Polytechnic School. In 1910 he was appointed assistant engineer on construction with the Quebec and Saguenay Railway, and later became associated with the Public Works Department of Canada in various engineering capacities. He is at present in charge of the new water works system proposed for Pointe-au-Pic.

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PRINCIPAL CONTENTS

NEW BRUNSWICK WATER POWERS COMMISSION

IN the interesting and valuably constructive article by Frank M. Small on the St. John River and its opportunities, which appeared in our last week's issue, there was the following statement:—

"The water-powers of New Brunswick were investigated by the Commission of Conservation this summer (1918), and pending the publication of its report, it is not desirable to discuss them at any length here."

It may be desirable to explain and correct this statement rather fully, as it is not in accordance with the facts and deals with an important matter. The author's error was entirely unintentional, and due solely to absence from New Brunswick for several months past.

James White, assistant to the chairman, and deputy head of the Commission of Conservation, in writing to *The Canadian Engineer* regarding the New Brunswick situation, calls attention to the fact that the report which the Commission of Conservation, after reconnaissance examination, made upon the water-powers of New Brunswick and of Nova Scotia, was published in 1911 in "Water-Powers of Canada." When the Commission issued this report, it urged fuller examination and the systematic gathering of stream-flow and other pertinent data in both provinces. "Subsequently," says Mr. White, "the provincial authorities of Nova Scotia requested the Commission to outline some course of action which would assist in the most advantageous development and conservation of the provincial water-power resources. Later, the Province of New Brunswick made a similar request.

"In the case of Nova Scotia, which province was first ready to proceed to action, the Commission of Conservation recommended that the province endeavor to effect some co-operative arrangement with the Dominion Government. Such an arrangement was brought about in 1915. The Nova Scotia Water-Power Commission was formed, and this Commission in turn entered into an arrangement with the Department of the Interior for assistance from its Water-Power Branch.

"When, a little later, the Province of New Brunswick again asked counsel of the Commission of Conservation with regard to its water-powers, similar action was recommended. Early in 1916, upon the special request of the Premier of New Brunswick, the Honorable the late George J. Clark, the Commission of Conservation's Consulting Engineer, Arthur V. White, made a report upon the subject. The Premier took steps to initiate the work. These various efforts culminated in the formation, in the early summer of 1918, of the New Brunswick Water-Powers Commission, which also effected a co-operating arrangement with the Department of the Interior, corresponding to that made by Nova Scotia.

"In 1918, certain public organizations in New Brunswick consulted with the Commission of Conservation upon the subject of water-powers. Our consulting engineer, Mr. White, paid a visit to St. John and other places, and advised the various organizations that the arrangements already made, if energetically and faithfully carried out, should meet all present requirements and lead up to the publication of a more detailed report upon the water-powers of the province. Doubtless, Mr. Small has, unwittingly, been under a misunderstanding, which I trust this statement will clear up."

THE NEW CONTRACTORS' ASSOCIATION

LAST month about two hundred very representative Canadian contractors and sub-contractors assembled in Ottawa for the most important general meeting that the contractors of Canada have ever held, resulting in the organization of a permanent body called the "Association of Canadian Building and Construction Industries." By-laws are now being prepared and a charter will likely be obtained. Every engineering-contractor in Canada should lend his active support to this new association. He will receive as much from the association as he gives to it,—and much more. Looking at the matter purely from a practical business standpoint, no Canadian contractor can afford to remain outside of the association.

In the United States a similar association was recently organized for much the same reasons that prompted the Canadian contractors to meet. Discussing the aims of the American association, "Engineering News-Record," of New York, says editorially: "Briefly, the object of the association, no matter what the actual wording of the constitution, is the stabilizing of the contracting business. If there is any industry in which the 'competition of incompetence,' the competition of the man who does not know what he is doing, has had more serious consequences we do not know what it is. It has defrauded the public, made hard sledding for legitimate contractors, and has resulted in the development of an attitude of suspicion on the part of the public that has caused grievous losses to the contractor, through contractual provisions lacking mutuality and imposing conditions that encouraged poor rather than good work.

"The new organization will establish standards that will force the elimination of this type of business man—against whom the Federal Trade Commission has so strenuously objected, the type of man who, until he goes down in inevitable ruin, is a menace to the whole industry.

"As to the detailed work of the association, it does not require much imagination to realize the large number of questions on which uniform practice is desirable and others in which the public, both private builders and Government agencies, city, state and Federal, needs enlightenment."

It is remarkable that no such association has previously existed in Canada. True, there have been Builders' Exchanges and associated exchanges, but never before have the contractors and supply men met in such whole-hearted co-operation and organized an active national council. No contractor of standing should hesitate in lending his enthusiastic support to the new Canadian organization.

PERSONALS

HENRY WICKSTEED, chief locating engineer of the Canadian Northern Railway, recently addressed the Toronto branch of the Engineering Institute of Canada on the economic aspect of the new tunnel at Montreal. While Mr. Wicksteed discussed the project chiefly from the financial and economic side, he also briefly outlined the engineering features of the work.

W. R. WORTHINGTON, whose appointment as acting engineer of the Ontario Board of Health was recently announced, was born in Toronto and educated in the public schools in that city. After matriculation at Harbord Collegiate he attended the University of Toronto, and in 1905 completed a post graduate course in civil engineering. Having had experience during summer vacations on the staff of the Department of Works, Toronto, after graduation Mr. Worthington was appointed assistant engineer of the sewer section of that department. In 1912 he was promoted to be engineer in charge of the section. This position will be retained by Mr. Worthington as the arrangement with the province is only a temporary one, pending the return of Capt. Dallyn, from Siberia. By arrangement between the city and the province, Mr. Worthington is giving without remuneration about half of his time to the work of the provincial department.

JAMES POWELL, chief draftsman of the motive power department of the Grand Trunk Railway, has retired after thirty-six years' service. Mr. Powell is secretary of the Canadian Railway Club.

LIEUT. W. D. STAVELY, of Montreal, formerly of the Canadian Engineers, but for the past two years serving with the Royal Engineers, has been awarded the Military Cross for conspicuous gallantry. He is a graduate of McGill University in civil and electrical engineering.

C. H. RUST, of the engineering staff of the Toronto Power Co., addressed the members of the Toronto branch of the Engineering Institute of Canada last Tuesday evening on "The Water Supply of the City of Victoria, B.C." The meeting was held in the Chemistry and Mining Building, University of Toronto. Until a few months ago Mr. Rust was city engineer of Victoria.

A. W. CAMPBELL, who until recently was Deputy Minister of Railways and Canals, has been appointed by the Dominion Government to report on the part which the government should play in the good roads movement. A number of bodies have urged that Federal aid be granted for the construction and improvement of highways, so Mr. Campbell has been asked to study the conditions. He is widely known as "Good-Roads Campbell," having been very much interested in the Ontario road system when he was Deputy Minister of Public Works for that province about eight years ago.

MAJOR C. AUSTIN BELL, who graduated from the University of Toronto in 1914, and who was dangerously wounded at Amiens on August 8th, losing both legs and the sight of one eye, has been awarded a bar to his Military Cross. Enlisting as a sapper in the 2nd Field Company, Canadian Engineers, he went overseas with the first contingent, and won rapid promotion and honors on the field. He was wounded at Ypres in April, 1915, and again a year later. Prior to enlistment he was Mines and Maintenance Engineer of the Canadian Copper Co. at Copper Cliff.

J. G. LAMB, formerly acting city engineer of Port Arthur, Ont., has resigned in order to accept an appointment with the Kipawa Fibre Co., of Temiskaming. Mr. Lamb will be associated with the engineering part of the construction of the company's new townsite, where housing accommodations will ultimately be provided for about 7,000 people The general construction contract is held by the Fuller Construction Co. Thos. Adams is advising on town planning. R. S. Lea and H. S. Ferguson are the consulting engineers, both for the town and in connection with the power development and mill building.

OBITUARY

GEO. C. LEGGE, resident superintendent for the Warren Bituminous Paving Co. on road construction at Sarnia, Ont., died December 1st from pneumonia, following influenza. Mr. Legge was in his fortieth year. Before joining the Warren company he had been engaged in prospecting and mining operations in New Ontario. He was a brother of W. H. Legge, Canadian superintendent of the Warren company.

SUSPENSION CABLES FOR BIG SPAN

IN the article by S. Svenningson published in the November 28th issue of *The Canadian Engineer*, prominent reference was made to the wire rope suspension cables used for the 4,800-ft., clear span transmission line which the Shawinigan Water and Power Co. built across the St. Lawrence River.

These cables and the tests on same were described in considerable detail on page 477 of the above-mentioned issue.

It has just been called to the attention of *The Canadian Engineer* that these cables, which, with the towers, comprise the main structural features of the undertaking, were "made in Canada," which is a point deserving of being put on record in connection with the description of such an important span. These cables were manufactured by the Dominion Wire Rope Co., Ltd., of Montreal.

WILL PROCEED WITH WELLAND CANAL

AS a part of the reconstruction program of the Dominion government, Hon. Dr. Reid, Minister of Railways, will at once proceed with the completion of the Welland Canal. This is the announcement that has been sent out from Ottawa by the Canadian Press, Ltd.

The estimated cost of the work embraced in the four main contracts under which construction was being carried on at the outbreak of the war, was twenty million dollars, of which twelve million dollars has already been expended. In addition to the estimated value of the main contracts, there were other necessary expenditures in contemplation for land, cement, structural steel bridges, lock gates, valves, etc., amounting to about eight million dollars, of which four million dollars had already been expended.

The Minister of Railways expects that there will be engaged during the winter a force of about eight hundred men preparing for the reopening of the work in the spring, when about four thousand will be engaged. Dr. Reid also expects to finish up work remaining to be done to complete the Trent Canal.

The Sixth Canadian Good Roads Congress will be held next May in Quebec, P.Q. A committee of six members has been appointed to arrange a program. There will be a number of addresses upon technical road-building subjects.