

Reference No. 68,134.

MONTREAL FLOOD COMMISSION.

REPORTS OF THE COMMISSION

APPOINTED by Order in Council of 28th May, 1886. to "Enquire into the causes of the floods at Montreal, and to suggest the necessary remedies to prevent their recurrence"; together with Order in Council appointing the Commission, and Report of the Chief Engineer of the Department of Public Works.

CERTIFIED COPY of a Report of a Committee of the Honorable the Privy Council, approved by His Excellency the Governor General in Council on the 24th May, 1886.

On a Memorandum dated 22nd May, 1886, from the Minister of Public Works, representing that a number of communications have been received from the City Council, Board of Trade, Corn Exchange Association, &c., of the city of Montreal, asking that a Commission be appointed by the Government to enquire into and report upon the causes which lead to the floods which annually devastate the city of Montreal;

That the City Council has offered to pay one-half the expense of such a Commission on condition that it be allowed to nominate one of the Commissioners, and that Mr. Walter Shanly, C.E., has been suggested as the representative of the City Council on such Commission;

The Minister recommends that a Commission be appointed to enquire into the causes of the floods at Montreal, and to suggest the necessary remedies to prevent their recurrence, and that such Commission be composed of Messrs. H. F. Perley, O.E., Chief Engineer of the Department of Public Works, as representing the Department, T. C. Keeser, C.E., as representing the Board of Trade and Corn Exchange Association of Montreal, John Kennedy C.E., as representing the Harbor Commissioners of Montreal, and Walter Shanly, C.E., as representing the City Council of Montreal—it being expressly understood that the latter gentleman is to be remunerated for his services wholly by the City Council, and that he is not to be paid in any way by the Government.

The Committee concur in the foregoing recommendation and submit the same for your Excellency's approval.

JOHN J. MCGEE, Clerk Privy Council.

Reference No. 68,134.

CERTIFIED COPY of a Report of a Committee of the Honorable the Privy Council, approved by His Excellency the Governor General in Council on the 28th May, 1886.

The Committee, on the recommendation of the Minister of Public Works, advise that the Order in Council of the 24th instant authorizing a Commission to investigate the causes of the annual floods at Montreal be rescinded, and that in lieu thereof Messrs. H. F. Perley, O.E., as representing the Department of Public Works, T. C.

Keefer, C. E., as representing the Board of Trade and Corn Association of Montreal, John Kennedy, C. E., as representing the Board of Harbor Commissioners of Montreal, and Percival W. St. George as representing the City Council of Montreal, be appointed a Commission to enquire into the causes of the floods at Montreal, and to suggest the necessary remedies to prevent their recurrence; it being understood that one-half of the expense of such Commission is to be paid by the city of Montreal. Reference No. 69,816.

JOHN J. MCGEE, *Clerk Privy Council.*

MONTREAL FLOOD COMMISSION, MONTREAL, 31st July, 1886.

SIR,—The Commissioners appointed to "enquire into the causes and suggest remedies" for the ice floods at Montreal, immediately upon their organization last month, made arrangements for the land and river surveys and the investigations necessary in dealing with so great a question, and these are now being actively prosecuted.

The Commissioners, conscious of the great desire on the part of the citizens of Montreal that every possible effort should be made to prevent the recurrence of the disastrous floods of April last, took immediate steps to deal with the protection of the district south of the Lachine Canal, relative to which a charter was obtained at the last session of Parliament for the construction of a dyke or levee. They have prepared, and herewith submit, a plan showing the position of the site proposed for this dyke, together with an estimate of the probable cost.

The area which would be protected by this dyke is bounded by the Lachine Canal, the River St. Pierre, the tail-race of the Montreal waterworks and the River St. Lawrence, from the city limits, as far down as the waste weir at Tate's dry dock, and includes nearly the whole of the municipality of St. Gabriel, excepting the islands in the St. Lawrence.

The area protected within the limits of the city of Montreal is about 360 acres, and in St. Gabriel about 300 acres. The assessed value of this area is nearly \$5,000,000, of which about \$1,800,000 is in St. Gabriel.

The route of the dyke is along the present road and top of river bank, from Tate's dry dock to a point about 3,000 feet above the Victoria Bridge. Here it turns inland, crossing the city limits at the rear of the property belonging to the Estate Knox and strikes the tail race embankment near Wellington Street—otherwise known as the Lower Lachine Road—passing in rear of the farm house on the property of the Congregational Nuns.

The tail race bank is now being raised by the city to the level proposed for the top of this dyke, which is 29 feet above city datum or summer level of Montreal harbor. The level of top of dyke would be 1 foot 6 inches above highest level of floods of April last, and is nearly the same as the coping of Tate's dry dock, as also of the rails of the Grand Trunk Railway where crossed by the dyke.

The connection of the head of the tail race with the Lachine Canal bank completes the route of the dyke.

The estimated cost of the dyke and the necessary pumping plant and drainage works required in connection with it will be about \$85,000. The land is valued at about \$35,000, making a total of \$120,000. The land valued is much more than will be required for the site of the dyke, as it includes the whole of such building lots as are affected by the close proximity of the embankment, also a considerable acreage of low ground, which is not suitable for building purposes, from which it is proposed to take the material required for the embankment.

The estimate for the drainage and pumping works also includes sewers, which, though now only wanted in connection with a dyke, will ultimately be of value to the city as sewers.

The estimate, and the right of way provided for, are for a dyke alone, but the culverts are lengthened to admit of widening the dyke for a future roadway.

The final location, breadth, &c., may be modified by arrangements with the proprietors. These are few in number and the most important of them are quasi-public bodies.

The Commissioners think it probable that it may be decided to construct at once the levee, on account of its simplicity, certainty of effect, the small amount of damage or inconvenience to be caused by it, and its moderate cost in proportion to the large amount of property it would benefit, as well as because any alternative scheme involves delay and the risk of further possible damage.

The protection of the remainder of the exposed district of the city, north of the Lachine Canal by raising the river front, is a work of much greater magnitude, involving as it does the almost entire reconstruction of the revetment wall. In connection with the plans and estimates required to show the cost of this work, the Commissioners are now conducting surveys and investigations for the purpose of ascertaining the practicability and probable cost of diminishing the floods, and of reducing them within harmless limits, by means of river works.

We have the honor to be, sir, your obedient servants,
 THOS. G. KEEFER,
 HENRY F. PERLEY,
 JOHN KENNEDY,
 PERCIVAL W. ST. GEORGE,
Commissioners.

A. GOBEL, Esq., Secretary Department of Public Works, Ottawa.

ESTIMATED COST OF PROPOSED POINT ST. CHARLES AND ST. GABRIEL DYKE.

Embankment, culverts, fencing, &c	\$ 37,400
Pumping and drainage works.....	41,600
	<u>79,000</u>
Engineering and contingencies.....	6,000
	<u>85,000</u>
Land valuation.....	35,000
	<u>120,000</u>
Total.....	<u>\$ 120,000</u>

Reference No. 77,053.

MONTREAL FLOOD COMMISSION, MONTREAL, 5th May, 1887.

SIR,—The Commissioners have the honor to report that they have completed the surveys and observations of the River St. Lawrence in connection with their investigation into the causes and suggestion of remedies for the floods at Montreal. These observations have extended from the ice packs below Morrisburg to Quebec, a distance of 250 miles; but the ice surveys have been confined to the portion of the river between the head of Lake St. Louis and the Platon, about 36 miles above Quebec—the lowest point at which an ice bridge was formed during the past winter.

The object of these surveys, the first of their kind which have been taken in connection with the ice question, was to ascertain the practicability of holding back above Montreal as well as of passing out to sea below Three Rivers a sufficient quantity of that ice which by its packing immediately below Montreal is the sole cause of the floods.

The field work in connection with these surveys, observations and ice charts was only completed last week, and on account of the many questions involved and the various projects supported by worthy persons, some time will be required to prepare our final report and to put on record the large amount of new and valuable information which has been obtained.

In view of the urgency of the question the Commissioners now beg leave to report the result of their investigations and the conclusions at which they have arrived, in order that prompt action may be taken to protect the city of Montreal before another winter.

In the first report, dated 31st July, 1886, the Commissioners presented plans and estimates for a dyke, or embankment, extending from Tate's dry dock at the head of Mill Street, along the river front to the St. Pierre River, at the lower Lachine Road, there to connect with the embankment of the water works tail race, and stated that they thought it probable "that it may be decided to construct at once this levee, on account of its simplicity, certainty of effect, the small amount of damage or inconvenience to be caused by it, and its moderate cost in proportion to the large amount of property to be benefited by it, as well as because any alternative scheme involves delay and the risk of further possible damage."

With respect to the protection of the exposed district north of the Lachine Canal by raising the river front, the Commissioners stated in that report that it was "a work of much greater magnitude, involving as it does almost the entire reconstruction of the revetment wall," and that in connection with this work they proposed to ascertain "the practicability and probable cost of diminishing the floods and of reducing them within harmless limits by means of river works."

The Commissioners have now to report, as the result of these investigations, their opinion, that, while an important diminution of the quantity of ice which is now arrested below Montreal may be effected by river works, or by annual work in the river, which may be the means of averting a flood in certain years—and more especially a winter flood,—in other years they might prove ineffectual for the protection of Montreal, especially against spring floods, and they are forced to the conclusion that there is no absolute certainty of protection for Montreal but in excluding the river by a dyke, or in raising the low districts above flood level.

EXCLUSION OF THE RIVER.

The questions connected with a dyke upon a permanent plan along the front, between the Canal and the Canadian Pacific revetment wall, are of such magnitude that, so long as there was hope of protection in any other direction, the permanent dyking of a portion of the city front must be regarded as a work of last resort.

The raising of Commissioners Street above flood level would be the most simple, permanent and effectual manner of dealing with the question, regardless of all other considerations. But this work calls for the simultaneous reconstruction of the revetment wall of a greater thickness and to a greater height, and upon its present site. Commissioners Street is too narrow for the present, and still more so for the early future requirements of the commerce of Montreal; nor can it at present be widened, because the wharfage width between it and the ships is equally insufficient, and the commerce of the port is of more importance to the city and the Dominion than the width of the street. Commissioners Street, therefore, cannot be widened, nor can its revetment wall be reconstructed where it ought to be for the purpose of a dyke until there is an advance of the whole wharfage front,—which carries with it an advance of the outer or eastern line of the dredged channel for its entire length. Again, the raising of Commissioners Street, to a height of at least six feet, means an unknown amount for property damages along the whole route, and extending inwards toward the city at every connecting street, so far as property would be affected by the rearrangement of street grades. But probably the most serious matter would be the interposition of a rampart, six feet in height, between the city and the port, over which all the tonnage must be carted. About ten years ago a commission of engineers recommended the widening of the wharves and of this street, and we understand that financial reasons alone have hitherto prevented any work being done in this direction; but, as Montreal will soon require all the harbor facilities which her position is capable of, there is very little doubt that this enlargement of the harbor front, and of Commissioners Street, will soon be undertaken, and until this is done it will be necessary to postpone the permanent dyke required as protection from floods.

Since the report of the engineers above referred to the question of the proper height of wharves, for the accommodation of the larger class of steamers, which the deepening of the river has brought to the port, has been raised. The present level of wharves was adopted when the shipping of the port was confined to vessels of a

few hundred tons. Ocean steamers of many thousand tons now frequent the port in such numbers as to need all the central portion of the harbor, and for these steamers the Commissioners understand a higher level of wharf would be more convenient. The higher the wharf level, the easier the cartage, and the less space occupied by ramps.

Montreal is the only city whose wharves are submerged continuously for five months in the year; and Captain Barclay, for many years in control of the loading and discharging of Allan's steamers, is of opinion that the level of Commissioners Street itself would be the most convenient one for the ships of that line. This, if applied throughout, would practically abolish the revetment wall, substituting the wharf front in its place.

The Commissioners refer to this question of wharfage height in consequence of its connection with that of a permanent dyke. The thickness and cost of a revetment wall depends upon its height, and as the permanent dyke must be either in connection with a new revetment wall or, in the absence of one, upon a foundation for the level of Commissioners Street, the condition precedent to its location and mode of construction is the settlement of these questions of the new line for the wharves and the height of the same.

The retention of the present level of the wharves with a new revetment wall so placed as to give a hundred feet width to Commissioners Street would, with the present system of wood construction, give the least amount of perishable work; and would cost about \$1,200,000.

To raise them to the level of Commissioners Street and provide a dyke against floods above that level would cost about \$1,700,000.

Should it be found advisable to raise the wharf level with its railway tracks and sheds above the winter level of the river—abolishing, thereby, the revetment wall and its ramps—all that will then be necessary for the protection from floods attaining a higher level will be a permanent dyke or rampart of substantial masonry, placed at a safe distance from the wharf front. The safe distance has been established by more than forty years' experience, as that between the revetment wall and the buildings fronting upon it. Openings through this parapet wall for cartage purposes would be closed by stop gates during the flood periods.

If the high or Commissioners Street level be adopted for the wharves along this portion of the city front, permanent sheds, bearing the same distance relation to the wharfage front, as the buildings on Commissioners Street now do to the revetment wall, would be resorted to, and the Commissioners think that the parapet wall could be utilized in the construction of such sheds.

It would also make possible an elevated railway, reaching the manufacturing districts at either end of the city without interrupting the traffic of the port.

The annual cost connected with the temporary sheds has been estimated as high as \$10,000. There is a further charge for removal of ice as well as the additional time and cost of cartage in favor of the high level wharf.

Whether these advantages will be considered sufficient to compensate for the half million dollars greater cost of the high level is in the future.

ELEVATION OF FLOODED DISTRICT.

The raising of the low districts above flood level involves an outlay upon twenty-six miles of streets in this district of upwards of one million of dollars, exclusive of the cost of raising the buildings and lots, and is, in any case, the work of years. For the purposes of flood prevention the raising of Commissioners Street alone would be sufficient, and nothing would be gained, except in a sanitary point of view, by raising any other street or buildings, because pumping must still be resorted to during floods, after the streets, lots and buildings have been raised, if the cellars are to be kept dry. It cannot be supposed that this whole district would be raised another six feet for the benefit of the cellars.

We have already referred to the questions connected with the raising of Commissioners Street, and would only add, upon the question of cost, that nothing is to

be gained in that respect by the raising of the street itself. Its necessary revetment wall would afford the required protection from floods, whether the street were raised or not, and this revetment wall is a necessary adjunct to the raising or maintenance of the street.

As there is, therefore, no means of protecting the river front north of the Lachine Canal upon any permanent plan, in time to provide against the contingency of another flood, the Commissioners have decided to advise the erection of a temporary dyke upon the top of the revetment wall, to be constructed of timber and earth-work, with openings through the same for access to the wharves, which are to be closed when navigation ceases. This can be effected in a short time and at a cost under \$50,000, which includes supporting the revetment wall where required, seeking for and cutting off old drains or leaks connecting with the river, so that the minimum of pumping would be secured.

ESTIMATES.

The present pumping plant was hastily improvised, and cannot be relied upon. It is moreover insufficient in capacity for the work it may be called upon to do during a flood, as there has as yet been no experience in pumping with the river at a higher level than the revetment wall.

For permanent plant about \$46,000 will be required, and this estimate is based upon the carrying out of the intercepting sewer, which we understand has already been determined upon by the city.

Since our estimate (of July, 1886) for the Point St. Charles dyke some expenditure of a permanent character has been made there for the drainage works, reducing by so much our provision under that head.

The cost of protection work will now be as under:—

Embankment, culverts, fencing, &c., Point St. Charles	\$37,400 00
Drainage works.....	14,000 00
Land valuation	35,000 00
Temporary dyke revetment wall, say.....	40,000 00
Superintendence, contingencies, &c.....	6,000 00
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	\$132,400 00
To which should be added for permanent pumping plant	46,000 00
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	\$178,400 00

We have the honor to be, sir, your obedient servants,

THOS. C. KEEFER,
HENRY F. PERLEY,
JOHN KENNEDY,
PERCIVAL W. ST. GEORGE.

A. GOBBIL, Esq., Secretary Department of Public Works.
Reference No. 79,824.

MONTREAL FLOOD COMMISSION, MONTREAL, 12th August, 1887.

SIR,—In obedience to your verbal request, made to one of their members, the Chief Engineer of Public Works, the Commissioners have the honor to report that they have prepared plans and estimates for a line of piers and booms at the lower end of Lake St. Louis.

In their report of the 5th May last, the Commissioners stated their belief that an important diminution of the quantity of ice which is now arrested below Montreal may be effected by river works, or by annual work in the river, that is—by holding back the ice above Lachine—or by passing it out to sea below Three Rivers.

Of these two methods one would be represented by works of construction in the river, requiring only the annual labor of opening and closing the booms, while the other, to be effective would require a capital outlay for properly constructed ice-breaking steamers, and considerable annual expenditure in fuel, wages and repairs. The action of the piers and booms would be independent of the character of the winters, while the cost, and even the practicability of the alternate method would materially depend upon the weather, and it was in view of this that the Commissioners recommended an experiment to be made last autumn with the tug boats of the Montreal Harbor Commission.

The practicability of arresting floating ice when young, and of causing ice to form at points where the current is sufficient to prevent freezing, by means of booms has been established upon the Ottawa River and its tributaries, notably at Deux Rivières, which point we have surveyed in order to compare the currents and conditions there with those in Lake St. Louis, below Ile Dorval; and we have come to the conclusion that the ice can be arrested at the points proposed by means of piers and booms, without the risk of any alteration in the winter levels of Lake St. Louis.

In the case of Montreal, the Commissioners, while holding the opinion that the stoppage of the ice in early winter below Dorval would reduce the floods, and even render them harmless in certain winters, felt that when the interests at stake were so great and a certain remedy was within the reach of those interested, it would have been unwise to assume any risks; but as regards the south shore of the St. Lawrence, below the Lachine Rapids, the conditions are reversed, and the only relief which can be expected for that quarter is in the holding back of the ice above Lachine.

The plan of holding back the ice has been publicly advocated from an early date. By whom it was first suggested is unknown to us, but we find it urged in the columns of the *Montreal Herald* in 1841; and in the report upon the Victoria Bridge by the Chairman of this Commission, in 1853, the opinion was expressed that "a line of piers across this lake, near Ile Dorval, would very much diminish the annual inundation at Montreal.

Since 1852—the year when the record of winter gauging at Montreal commenced—the river has closed ten times in the month of December, and always without a winter flood. In the other twenty-six years it has closed in January. The effect of severe continued frost, at the beginning of winter, is to close Lake St. Louis, and cut off further supply of ice from above the points where it freezes over, and thus prevent a winter flood, which is the most distressing one.

Again, if the ice were held in Lake St. Louis until the river is open below Montreal, the severity of the spring floods should be diminished. Until last April it was the descent of the lake ice, before the river was open below Montreal, that caused the spring floods; but the shove and flood took place last spring before the lake ice passed below Victoria Bridge. The river below Montreal was so filled with ice, which came down from the city before the La Prairie Basin and Lake St. Louis were closed for the winter, as well as by the ice formed in the open water below this lake throughout an exceedingly severe winter, that it did not need the addition of the lake ice, in the spring, to cause a flood.

The effect of a line of piers and booms below Ile Dorval will be to prevent the descent of any ice from above them, until the booms are opened in the spring; and also to cover with ice a large portion of Lake St. Louis, extending to a considerable distance above Dorval, which is now an open water factory of frail and bondage ice, which by the action of frost and wind is sent over the Lachine Rapids throughout the winter. The greater part of this ice is carried under the surface through the La Prairie Basin and is packed somewhere between Montreal and Varennes.

The number of piers, each of which will be thirty feet square on foundation, will be nineteen; and the length of two ply boom will be about fifteen thousand feet, or nearly three miles. The cost of the whole we estimate at \$70,000. The Commissioners recommend the carrying out of this work as one which, in proportion to its

cost, will in their judgment produce greater beneficial results to the exposed districts outside of Montreal than any other river work they are able to suggest.

We have the honor to be, sir, your obedient servants,

THOS. C. KERFER,
HENRY F. PERLEY,
JOHN KENNEDY,
PERCIVAL W. ST. GEORGE,

Hon. Sir H. L. LANGEVIN, K. O. M. G., &c., Minister of Public Works.
Reference No. 80,648.

CHIEF ENGINEER'S OFFICE, OTTAWA, 8th September, 1887.

SIR,—As per the endorsement by the Hon. the Minister, on Fyle No. 78,824, I am to state the particulars of the works proposed by the "Flood Commission" to be built in Lake St. Louis, for preventing wholly or in part, the passage of ice formed in the early part of each winter in the lake, or brought down into it from Lake St. Francis—down the Lachine Rapids, through the Laprairie Basin, and past Montreal, to jam and accumulate, and thus add to the probability of recurring floods and inundations, not only in that city, but over the southern shore of the St. Lawrence below the Lachine Rapids.

The Commission has stated fully why they have recommended the construction of piers and booms in Lake St. Louis, and it only remains for me to say that the piers will be 19 in number, each 30 feet square, built with sloping faces on the upstream ends, and properly protected to withstand the run of ice in the spring. These piers are to be placed at the lower end of the lake, and in such positions as will not interfere with navigation, and where a line of shoal water extends from shore to shore, they are to be placed about 500 feet apart, and between them booms will be stretched after the close of navigation, which, from the experience gained on the Upper Ottawa will have the effect of causing the ice to form completely across the lake early in the winter, and once taken the pressure on the booms will be reduced, and all ice formed in the lake or brought into it, must remain until the breaking up in the spring. At present the ice forms out from the shores (bordage), and is broken up by winds and storms and carried by the current to the foot of the lake, thence through the Lachine Rapids, &c., to and past Montreal, and this process or action continues until the bordage on either side has become connected and a solid unbroken sheet has been formed.

Just before the breaking up of the river in the spring, one end of each boom will be cast loose, and with the flow of the ice they will swing freely and without damage, and can so remain until required to be placed in position for the following winter.

I have examined the details of the estimate of cost prepared by the Commission, and believe that it will be barely sufficient to cover the cost of the works proposed, as I differ in some points respecting the mode of constructing the piers, for with my experience in connection with the piers built by the Department at Laprairie, Chenal du Moine and Berthier, I am of the opinion that a heavier plan of construction must be adopted. The plan of boom prepared and the fastenings and mode of attachment to the piers are satisfactory.

If these piers and booms are to be of any service next spring, their immediate construction is very desirable, and if they are to be proceeded with and to hasten their speedy completion, the work of construction might be let in several, say five or more, contracts.

If the foundations can be put in before the ice makes and the booms stretched, and I see not reason to prevent this being done, the superstructure can be completed after the ice has formed, when there will be ample opportunity for the conveyance of materials—namely ballast to each pier.

I am, sir, your obedient servant,

HENRY F. PERLEY, *Chief Engineer.*

A. GOBBIL, Esq., Secretary Public Works Department.
Reference No. 70,063.

CITY CLERK'S OFFICE, CITY HALL, MONTREAL, 20th August, 1886.

SIR,—You are no doubt aware that the Commissioners appointed by the Federal Government to enquire into the cause and suggest remedies for the ice floods in Montreal have submitted a preliminary report recommending the immediate construction of the proposed dyke or levee along the river bank west of Tate's Dry Dock, at an estimated cost of \$120,000.

At the meeting of Council held last Wednesday, that report was referred to a special committee composed of Aldermen Grenier, Laurent, Donovan, Stevenson, Mooney, Rolland and Hamolin.

At a meeting of that committee held this day, it was resolved—That whereas the proposed improvement is one in which the Federal Government, the municipalities of St. Gabriel and Verdun, the Grand Trunk and Canadian Pacific Railway Companies as well as the city of Montreal are interested, the City Clerk be instructed to write to these several parties to inquire to what extent they will be disposed to co-operate with the corporation of the city of Montreal in meeting the cost of carrying out the projected works. The present letter is therefore addressed to you with a request that you will favor the committee with your answer in time for their next meeting which will take place at three o'clock p.m. next Wednesday.

I have the honor to be, sir, your obedient servant,

CHAS. GLACKMEYER, *City Clerk*.

Sir HECTOR LANGEVIN, Minister of Public Works, Ottawa.

Reference No. 76,084.

CHIEF ENGINEER'S OFFICE, DEPARTMENT OF PUBLIC WORKS, CANADA,
OTTAWA, 23rd August, 1886.

SIR,—The city clerk of Montreal asks to what extent the Federal Government would be disposed to co-operate with the corporation of the city of Montreal in meeting the cost of carrying out the works proposed by the commissioners appointed by the Federal Government to enquire into the causes and suggest remedies for the flooding of Montreal, for the protection of the Point St. Charles district—so-called.

With reference to this request I beg leave to state that in my opinion the work in question does not possess any federal characteristic, but is one in which the city of Montreal is chiefly interested, and the property to be protected is not owned or controlled by the Federal Government, nor is the flooding of this property, which the works proposed is to prevent, due in any way to causes within the control of the Federal Government.

I am, sir, your obedient servant,

HENRY F. PERLEY, *Chief Engineer*.

A. GORRELL, Esq., Secretary Public Works Department.

Reference No. 70,164.

MEMO.—Telegraph Mr. Chas. Glackmeyer that so soon as the members of the Privy Council have returned to town his letter will be submitted to the Council.

H. L. L.

Then lay before me again.

H. L. L.

Reference No. 70,515.

REPORT OF THE SPECIAL COMMITTEE ON INUNDATIONS APPOINTED
BY THE COUNCIL OF THE CITY OF MONTREAL, ON THE 12th
JANUARY, 1884.

EXTRACT FROM THE MINUTES OF A MEETING OF THE COUNCIL, HELD ON THE 14th
JANUARY, 1884.

On motion of Alderman Stevenson, seconded by Alderman McShane.

Resolved, That a special committee composed of three members of the council be named to make investigations into the cause of the recent inundation and forward

inundations of certain portions of the city, and that they be authorized to associate with them one member of the Board of Trade, and one member of the Corn Exchange, with instructions to report to council, as early as possible, what proceedings may be necessary in order to prevent similar inundations in the future, and that said special committee be composed of Alderman Stevenson, Laurent and McShane.

Certified.

CHAS. GLAOKMEYER, *City Clerk.*

The same Committee was reappointed on the 10th March, 1884, and on 16th March, 1885.

Members of Committee.

Alderman Stevenson, Chairman.
Alderman Laurent, D. A. P. Watt, Esq.,
do McShane, Robert P. McLea, Esq.

REPORT OF THE INUNDATION COMMITTEE RECOMMENDING A SURVEY FROM VICTORIA BRIDGE TO BOUCHERVILLE.

To the Mayor and Aldermen of the City of Montreal :

The special committee appointed to consider the question of the periodical inundation of the city of Montreal respectfully report :

That shortly after their appointment a number of meetings were held, and a large amount of valuable information secured, by the examination of witnesses, some of whom appeared at the request of the committee and others volunteered statements on the subject.

The committee made it generally known that they were desirous of collecting together any facts bearing upon the subject, and in order to ascertain whether any observations had been made by the adjoining municipalities, they addressed communications to the municipal authorities of Hochelaga, Longue Pointe, Boucherville, Varennes, Longueuil, St. Lambert, Laprairie, Verdun and other places in the vicinity. The information obtained from the last mentioned sources was very meagre, as no continuous system of observations appear to have been in any case attempted, and generally it may be said that the want of reliable data on this important subject is somewhat remarkable. As might be expected, wide differences of opinion were elicited as to the causes of, and the remedies for, the flooding of the city of Montreal, it being generally conceded that the conditions producing these inundations vary from year to year.

On two points, however, all agree, that the removal of obstructions now existing between the Victoria Bridge and the Boucherville islands, on both sides of St. Helen's Island, and the general widening and straightening of the deep water channel of the river, are both calculated largely to diminish the liability to inundation, as well as to mitigate its extent, under all circumstances.

As a result of their present enquiry your committee have therefore no difficulty in reaching a recommendation, to the effect that a careful survey of the bed of the river between the points mentioned, be at once instituted, and they suggest the obvious advantage which would be derived by securing the co-operation of the Harbor Commissioners, who already possess the best existing data and have also the requisite staff and appliances for immediate work. Their chief engineer, Mr. Kennedy, estimated that such a survey could be made for a very moderate sum and completed in a few weeks.

Your committee therefore recommend to the council the granting of an appropriation of say \$50,000, for this purpose, that being the amount which Mr. Kennedy estimates it would cost.

The evidence adduced before this committee, comprising statements made by Messrs. John Kennedy, harbor engineer, J. M. Nelson, his assistant, Geo. H. Henshaw, C. E., L. Leese, Supt. M. W. W., P. W. St. George, city surveyor, Alfred

Brittain, assistant city surveyor, Captain Chas. Leger, pilot, Alderman Mount, Messrs. T. B. de Grosbois, James Shearer, Joel O. Baker, John Galbraith, J. G. Dining and O. G. Jones, is submitted herewith, and which, in the opinion of your committee, ought to be printed for future reference.

As this question is of paramount importance to the city of Montreal, your committee suggests the desirability of either continuing the present special committee, to superintend the survey above referred to, or to have this done under such other superintendence as the council may see fit to determine.

The whole nevertheless respectfully submitted.

A. A. STEVENSON, *Chairman.*

M. LAURENT,

J. McSHANE, jun., } *Representing the City Council.*

T. CRAMP, *Representing the Board of Trade.*

DAVID A. P. WATT, *Representing the Corn Exchange.*

COMMITTEE ROOM, CITY HALL, MONTREAL, 10th July, 1884.

Finance Committee's report concurring respectfully report that, as directed by the council, they have considered the accompanying report of the special committee on inundations for an appropriation of \$500 for a survey of the bed of the St. Lawrence, between the Victoria Bridge and the Boucherville Islands, and that they concur in the recommendation therein made.

The whole nevertheless respectfully submitted.

J. GRENIER.

J. FAIRBURN.

M. LAURENT.

J. H. MOONEY.

COMMITTEE ROOM, CITY HALL, MONTREAL, 11th September, 1884.

THE EVIDENCE.

EVIDENCE OF MR. O. G. JONES, REAL ESTATE AGENT.

Build another Bridge.—Montreal Inundation.

MR. CHAIRMAN,—I had intended giving my views through the press, but will avail myself of the opportunity which this meeting presents.

We are all agreed that the flooding is caused by ice dams. Now, can we in any way affect the ice so as to prevent it damming up? I think we can. I may say I agree in the main with the opinions of those gentlemen contained in the *Witness*, which appeared in the first article on this subject, but think too much stress was laid upon the frail as being such a factor in causing the dams. My experience of running water has led me to the conclusion that it requires something solid than frail to block a mighty stream like the St. Lawrence. I believe it is the solid masses of ice alone we have to deal with, and not with the frail. I can understand after the dam is formed how the smaller pieces help to complete the work, but the small pieces would never form a dam, and if the larger pieces could be chopped up fine, there would be no damming and consequently no flooding. You may ask how all this chopping is to be done. I will tell you how, by building another bridge. I think it generally admitted that since the construction of the Victoria Bridge the ice floods have been few and far between.

Now if one bridge will have such effect what would not a second one have? In my opinion it would chop the ice so fine that it would be impotent to create any dam. I am further strengthened in this opinion from what came under my observ-

ation and knowledge during the last high spring floods some ten years ago. The ice here—at Longueuil—was solid. The weather having been cold, it showed no signs of breaking up, but a different state of things prevailed up west and south; they had had warm thawing weather, causing sudden freshets and the breaking up of the rivers flowing into the St. Lawrence. Consequently the ice came down in solid masses, and finding the ice here unyielding, went underneath, doubtless grounded, and caused the flood. (While looking at the flood, a man from Beauharnois told me the ice had all come down from the rivers and lakes above the night before.) Now had there been another bridge, the ice coming in contact with this second set of abutments would have been broken up into such small pieces, that though being drawn underneath the solid ice, could not have caused a dam, and Montreal on that occasion would certainly have escaped a most disastrous flood.

This bridge should be located just below the Victoria, where it would in no way interfere with navigation. The other advantages to be derived apart from this, both to the city and country from a second bridge, are too well known to dwell upon at this time. I have already pointed them out in the press. Any money expended in this way would not be thrown away, but would bring in a good return from railway, carriage and passenger traffic. I would therefore suggest that, before money is expended in experimenting, another bridge be first built. I would not say that this would be a perfect remedy for the evil we are discussing, but it would greatly ameliorate it by lessening the frequency of the floodings.

C. G. JONES.

MONTREAL, 1st April, 1884.

EVIDENCE OF MR. JOHN G. DINNING.

Remove Moffat's Island, Isle Ronde and the St. Helen's Island Shoals.

1. The current rushes towards it at the rate of twenty miles an hour carrying the ice against it. Driven therefrom, it is forced out into the channel, carried to the Ronde and jams there. Moffat's Island removed and the space deepened, say to six feet, the ice would be carried against the upper end of St. Helen's Island and the north side of the river behind the Island, thus disposing of the greater portion of the lake ice when it arrives.

2. Remove the shoals which exist from the upper to the lower part of St. Helen's Island, deepening the space to at least ten feet, thus leaving a wider channel for the ice to pass down.

3. Remove Ile Ronde entirely, deepening the space to the extent of eighteen feet, continuing the same throughout the length of the bay of Longueuil, thus providing a channel deep enough and broad enough for the free passage of the ice, thus freeing the city from inundation.

4. Should a jam occur at the Boucherville Islands, remove the small island on the south side of the river, and deepen the space to eighteen feet.

Had Montreal been inhabited by Americans, St. Helen's Island would have been removed fifty years ago had it caused the flooding of the city. A disgraceful apathy has always existed in Lower Canada, while Ontario goes on loading us a century behind.

The remedies proposed could by proper management, be effected by the employment of the many able-bodied men who are too lazy to work. These are to be found in hundreds in the Gaol and House of Industry.

The sand and stone removed from the river could be disposed of for building purposes, and for repairing the roads. The roads in Spain are repaired by convicts guarded by soldiers.

JOHN G. DINNING.

MONTREAL, 29th March, 1884.

NOTE.—The above is a synopsis of the five letters published in *The Star*.

JOHN G. DINNING.

EVIDENCE OF MR. JOHN GALBRAITH.

Erect Piers and Booms above Lachine Rapids.

Mr. John Galbraith said most of those who had already given their evidence before the committee, or through the press, had justly attributed the flood to a great extent to the formation of anchor ice, which is produced in great abundance in the rapids and open water above, choking up the more shallow parts of the river while the river is still low, and driving the main body of the water into the deeper channel, causing a shifting of the surface ice, that has by this time formed by the same severe cold that produced the anchor ice, and thus producing a new and greater difficulty, such as has existed all the past winter below our city.

Mr. Hodges, Contractor's Engineer for the building of the Victoria Bridge, published a book in 1861, being a description of his great work, and takes occasion to make the same remarks regarding the Montreal floods, and no man had a more lively appreciation of the difficulty, its course and extent. Such then being the cause of our floods, they ought to prevent the production of anchor ice.

He said there was a great deal of misapprehension concerning anchor ice and how it is formed. He had seen a letter in the *Gazette* throwing ridicule upon the statement that there could be anchor ice.

In answer to a question about the widening and deepening of the channel below the city as a preventive, Mr. Galbraith expressed the belief that every effort in that direction would be of service, but the difficulty of getting a sufficient fall of water below the city would render these efforts comparatively valueless.

The person who wrote that article in the *Gazette* could not have been long a resident of this country or he would have known better.

Anchor ice is formed mostly in the Lachine rapids and in the waters above them where the water was open, and appeared more like cart loads of sludge than solid ice. He had seen large cakes of ice rise from the bottom of the water. It only formed when the temperature was about 10 or 15 degrees below zero, and where there was a rocky bottom; it would not form on wood or mud.

Anchor ice and frazil were entirely different; anchor ice formed at the bottom and frazil in the body of the water. Frazil is anchor ice, or, rather, ice in its inception form, but having failed to attach itself to a conductor by the rapidity of the water motion; snow falling into the water and being congealed under different conditions, then ice will sink in the water and add to the frazil floating there and help to produce the obstruction complained of. He attributed the formation of anchor ice to the water on the top becoming cold and falling to the bottom, where, if it met with some good conductor which would carry off its latent heat, it froze solid and only reappeared at the return of mild weather when it was liberated and came to the surface. The reason why there was so much anchor ice in the St. Lawrence he believed to be on account of the vast extent of open water in and for ten miles above the Lachine rapids affording sufficient time to effect a process of equalization of temperature down to the freezing point before reaching the cover below the rapids and thus becoming fastened to the rocky bottom, being helped much by the agitation of the rapids in becoming still more firmly rooted thereby.

If they could devise some means to provide a covering for the water and so prevent the heat from radiating, the anchor ice would not form. This, he thought, might be done by building an arc of piers, with booms thrown across in winter to facilitate the process of taking. The water would at once begin to freeze in winter at the sides and gradually extend back until the whole of the open water would be frozen over. The dam at Carillon had had this effect. The piers, he thought, should be built across the river about a mile above the first break of the Lachine rapids, care being taken to have them sufficiently close together to effect the closing of that part of the river, the piers thus forming the necessary shoulder to the ice-cover. For purposes of navigation, the centre space in mid-channel should be made wide enough for steamers to get through with safety. The barrier thus formed would keep the

upper ice sufficiently long in the spring of the year to give time for the ice in front of the city to undergo considerable liquefaction and less capable of resisting the upper ice when it should come down; and, in this way, would save us from the spring flood also. Lachine would suffer no inconvenience by it, but, on the contrary, would be greatly benefited by the ice bridge so formed.

Mr. Galbraith said also that the water issuing from under this proposed cover would retain a large portion of its natural heat and would reach the cover below the rapids without having parted with it to that degree necessary to produce anchor ice, except in extremely cold weather, say 35 degrees below zero.

Mr. Baker said he agreed with Mr. Galbraith that where there is a covering to prevent radiation, nothing will freeze underneath. Thus, anchor ice would not form under surface ice. The St. Lawrence was one of the greatest factories of anchor ice in the world owing to the open water at the Lachine Rapids and Lake St. Louis.

Mr. Galbraith continued to say, that if the water below and above our city were less rapid and turbulent, so that a higher degree of temperature would suffice in effecting its close, the difficulty would not be so great. The most difficult thing was to start the formation of the ice for the covering, and this was the benefit of the boom. It would also serve to retain the upper ice until that below the city had a chance to break up.

JOHN GALBRAITH.

EVIDENCE OF MR. JOEL C. BAKER.

The Principal Obstruction at Boucherville.

Mr. J. C. Baker said that when a young man he was in the habit of going at Christmas and Easter by way of the river to his house in the county of Missisquoi, and therefore had frequent opportunities of watching the state of the river at these times and the changes it underwent. What caused the dam was the frozen ice and frazil that came down and caused an obstruction and made a very perfect dam.

These obstructions do not occur generally in deep water but in shallow places; and they tend to scoop out a deep channel. The ice for a great many years has shoved down about as far as Boucherville, and by a chart the places where the obstructions took place could be very easily seen. The important feature was that we have a deep channel, and if we could have it wide as well as deep, it would serve to carry off the ice and frazil. The remedy, therefore, seemed to him to be the improvements to the ship channel, all of which he considered served to create a waterway for the ice. The ice shoves before the erection of the Victoria Bridge were much greater and more frequent. The only feasible remedy seemed to him to be to give all the room possible to allow this floating ice to get out of the way. The Lachine Rapids were one of the biggest manufactories of frazil in the world. This frazil must be carried down and cannot in any way be checked without checking the water at the same time. He had been convinced for many years that all the improvements undertaken by the Harbor Commissioners to the ship channel were in the direct interest of the city, as tending to remove the difficulty. Wherever they could widen, deepen and straighten the channel they would be doing much towards remedying the great difficulty.

Mr. Thomas Cramp asked if the main obstruction generally took place near the same spot?

Yes; generally about the Boucherville Islands, but I have noticed obstructions at other places, especially about Moffat's Island and at other places above the harbor. But the great difficulty has been below the harbor, and the other obstructions were only secondary.

Mr. Cramp:—Then the obstruction at Boucherville Islands is the real point?

That is my opinion. You have got to go there to get to the root of the evil, and by this way only will the difficulty be remedied.

Mr. Cramp:—Have you paid any attention to the matter this year?

Well, I have been over a considerable portion of the ground this year.

Mr. Cramp :—Is the phenomenon about the same this year as in past years?
There can be no doubt that it is.

Mr. Cramp :—You then attribute the immunity we have enjoyed for many years from floods to the improvements to the ship channel?

Yes, I certainly do, and think that these can be the only remedy for the difficulty in the future.

The Chairman :—Does the frasil form every year or only in certain years?
It forms every year more or less.

Mr. Cramp :—The most serious enemy is therefore the frasil?

Mr. Baker :—Yes, I think so.

Mr. Cramp :—Do you think that if by any artificial means the ice could be detained in its course a passage could be obtained for the frasil?

The ice itself would not make a close dam, but the frasil is also carried in by the water and makes a perfectly impervious dam. The frasil without broken ice would, I think be carried down, as it has not substance enough to remain and form a dam.

Mr. Cramp :—How long have you been paying attention to this subject?

I commenced my observations first in 1849. My observations have been of a personal nature. I have written several letters to the public on the subject, and my opinion on the matter of floating ice and frasil are entirely my own, derived from personal observation. I have copies of the letters in question, and am willing to submit them to your committee for consideration.

J. O. BAKER.

EVIDENCE OF MR. JAMES SHEARER.

Clear the Channel south of St. Helen's Island of all obstructions.

Mr. James Shearer thought the surface ice had more to do with the flood than the frasil. The late flood was a more peculiar one. We had a very cold fall with no snow for a time, and the ice, of course, formed very thick, for it was a well known fact that the formation of ice was much slower when the snow lay thick on the ground. Then came a strong south-west wind which lasted for several days and broke up the surface ice, sending down the solid green blocks, which blocked up the south channel completely and the north one partially.

Then a jam formed at Boucherville of these blocks, the frasil filling up the interstices. But the jam was not here altogether, for while the water rose twenty-one feet four inches at the foot of the canal, it only rose twelve feet at Longueuil. If the jam was wholly at Boucherville, Longueuil should be submerged to the depth of about eight feet.

The cause of this was the south channel being completely blocked with ice and the whole of the water having to pass by the north channel. The south channel was full of islands and boulders, and the ice being obstructed thereby, piled up on it to the height of fifteen feet, in blocks of one foot in thickness. He considered the only cure was to clear out the south channel of all obstructions, and when the river rose as it did this spring, the water would have a channel 2,800 feet in width and six feet in depth to pass through. They should not deepen the channel, as that would lower the water opposite the city.

This plan would not affect the navigation, as in summer the south channel would be as shallow as ever. The wharf at St. Lambert should be done away with, as it lay directly in the current. The long wharf should also be removed for a similar reason, but they should not touch Ile Ronde, otherwise they would lower the water in the harbor.

The ship channel should be widened and deepened, the debris taken out being placed at the sides of the river so as to keep up the level. There was deep water round the back of St. Helen's Island with only one shoal of about 2,000 feet in length, and if this was removed they would have a steamboat channel there. The jurisdiction of the Harbor Commissioners only extended to the middle of the river so that they have never interfered beyond it.

JAMES SHEARER

EVIDENCE OF MR. T. B. DE GROSBOS.

Clear the course from Longueuil to Boucherville.

CHARLES GLACKMEYER, Esq., City Clerk of Montreal :

SIR,—The Mayor of Boucherville having requested me to answer your letter, asking information on the subject of the inundations, I take the liberty to make known to you my observations concerning the inundations. Having always lived on L'Île St. Joseph, at Boucherville, it has been easy for me to observe the inundations.

Inundation years at Boucherville.

The first took place in January, 1860, the second in April, 1862, the third in 1865, the fourth in 1868, the fifth in 1870, the sixth in 1872.

Since that year we have had no great inundation; the water rose occasionally, but no jam seems to have formed; and the water caused little damage.

The greatest inundation took place from the 23rd to the 25th of April, 1862, and the water rose at least 20 inches higher than at any previous time.

In the month of December, 1883, and in January of that winter, the water rose a little, but a jam having formed near Longue Point, the water subsided here, and when the water was very high at Montreal, it was relatively low here.

Cause of Inundations at Boucherville.

The inundations at Boucherville are caused by the piling up of ice on the lower portion of the Island of Varennes, and the *battures* of the Pointe aux Trembles. This is demonstrated by the strength of the current which there throws itself into that part of the river to the south of the Islands of Boucherville, and which I will call the Boucherville River. On the 23rd of April, 1862, the water rushed on with such a force towards the Boucherville River that canoes could hardly be used; the same thing happened in 1872. The *batture* situated on the Boucherville River, on the lower portion of the Île St. Joseph, caused a small jam in 1870, and a commencement of the same last autumn.

Cause of Inundations at Montreal.

The inundations at Montreal are caused by the piling up of the ice in the *battures* of Longue Pointe and the Islands of Longueuil. I will remark that the parish of Boucherville ends at the Moisson channel, and that the islands situated higher up than the channel are in Longueuil parish.

The river forms at this place a cul-de-sac, which has no outlet but the ship channel near Longue Pointe. It was not enough, it appears, that this vicious conformation of the river caused damage to Montreal, the Harbor Commissioners had the earth removed by the dredge dumped all along the Longueuil Islands, so as to form a *batture* and almost block the Boucherville River at its mouth. All the rubbish from the holds of vessels coming into port and the sweepings of the port were thrown into the same place last summer, poisoning the Boucherville River. Several complaints were made and with very little results.

Another fact to show how little care was taken against obstructing the river. During the summer of 1882, the Government had the channel deepened between Boucherville and Longue Pointe. The earth was thrown on each side of the channel. I do not know if it was thus thrown throughout the whole length of the cut, but in several places it is exposed at low water. Imagine a shoal about thirteen arpents long almost across the width of the river. Last summer the ferry boat got aground during a storm; it had just been got afloat when it again struck on the *battes* formed by the dredges.

When we examine this year's jam, we see that it is very close to this bar.

The dredges which excavated the channel in the *battures* of Pointe aux Trembles and at the head of the Ste. Thérèse, also threw the earth into the river in places dangerous for the ice; it was even thrown into a pretty deep channel opposite the

north side of the Ile à Cardinal or Ile à Dufaulx. This earth should always be thrown at the end of an island, and never at the side.

The slope of the river between the *battures* of Longue Pointe and those of Pointe aux Trembles being inconsiderable, I am persuaded that a jam formed on the *battures* of Pointe aux Trembles and the lower portion of the Islands of Varennes would cause an inundation in Montreal if the Boucherville River was obstructed as it is this year. But when there is no jam in this river the water escapes that way, and this is what explains how it is that there has not always been an inundation in Montreal when there was one here.

This Year's Jam.

The jam which exists to-day was caused by a shoving of the ice, composed largely of snow ice. It took place on the 27th of December in the night. The ice descended St. Mary's current and piled up on the *batture* of Longue Pointe and the Islands of Longueuil.

The Boucherville River was blockaded between the Longueuil Islands, and was free from ice until the lower portions of Ile St. Joseph. This blockade was not a jam; it occurs at this spot nearly every autumn. The people here called it *la barrure*. It consists of a bank of ice too great for the entrance of the river and which remains there; it is only a few inches thick. During the shove, a portion of this block came down the Boucherville River, and stopped at the foot of the village, forming on its passage enormous jams. At present the Boucherville River is half blocked by jams. The other portion of the block stopped at the small Islands of Longueuil and on the *batture* formed by the Harbor Commissioners, making a jam which extends from the property of Mr. Damase Charron, on the Island, till near the property of Mr. J. M. Browning, on the Longueuil shore.

A portion only of the entrance to the Boucherville River is free from ice. The snow now hides a part of it, and this explains Mr. Nelson only mentioning one portion of it, that to the west of Mr. Charron's farm. That part which extends to the Longueuil hill was easily visible at the beginning of January.

The ice did not move during the shove below the jam on the Pointe aux Trembles side. At this place the ice was formed of water without snow. I noticed that the snow ice is more dangerous for jamming than the green ice.

Means of Preventing Inundation.

I do not think there are any absolute means of preventing inundations, but some may be of great assistance. Those I will take the liberty to suggest will, I think, be advantageous to Montreal and its environs.

I will mention three:

First means.—To prevent anyone whatever from throwing earth into the river in places dangerous for ice. The earth excavated in the port should be thrown at the upper part of the small Islands of Longueuil, and not on the west side, so as to lengthen the Island and not to widen it.

The earth from the *battures* of Pointe aux-Trembles should be dumped at the lower end of the first Islands of Varennes.

The channel between Boucherville and Longue Pointe should also be examined next spring, and if the earth has been dumped all along the shores as it is in certain parts, it should be removed without delay.

Second means.—It would be necessary to deepen the river on the Boucherville side, i.e., at the two extremities of the Islands of Longueuil and St. Joseph, near the properties of Messrs. Damase Charron and G. Deschambault. If a jam should occur on the *battures* of Longue Pointe or Pointe aux Trembles the water would escape by the Boucherville River, which empties itself lower than the *battures* of Pointe aux Trembles.

Somebody has suggested excavating the *batture* of Longue Pointe. But let us suppose that the jam between the islands and Longue Pointe should be on the *battures*

of Pointe aux Trembles, the Boucherville being obstructed as it is now, the water could not escape by Boucherville and the result would be the same for Montreal.

Let us remark that it would only be necessary to deepen the two extremities of the Boucherville River, because elsewhere the water is deep.

Third means.—This would be principally in view of preventing inundations in the autumn—those which cause the most damage. It would not cost much. It would consist in forming two or three small islands, a few hundred yards of earth dumped on the lower portion of Ile St. Joseph on the Boucherville side.

The reason is this: From the first frosts of December, the river carries ice towards Boucherville, but the mouth of the river in the Islands of Longueuil being narrow, the ice immediately piles up leaving the rest of the Boucherville River free from ice. When the ice ascends St. Mary's current, it shoves and breaks down this barrier, which then piles up on the islands of Longueuil and causes a jam on that side. See what happened last autumn. This blockade caused the jam in the Boucherville River. All the residents of the islands feared the descent of the blockade. This is always a cause of trouble in the river.

The small islets I should wish to see formed would have the effect of stopping the first ice in the autumn, and good ice would form on the whole Boucherville river from the lower portion of Ile St. Joseph to St. Helen's Island and this on the first frosts. This portion of the river would be strong enough to resist the shove, which would only be felt along the shore, as was shown by experience for several years, and it would be a surety that no jam would form from the north-east portion of St. Helen's Island to Varennes, on the Boucherville side. Let us suppose that a jam were to form on the *battures* of Longue Pointe or Pointe aux Trembles; a third of the river at least would be free and would give passage to the water.

I remember three years when the ice had shoved opposite my property in Ile St. Joseph and Boucherville Village. The shove was considerable, and nevertheless it was only felt a little on the shores of the Boucherville River. When all the Boucherville River is covered with good ice as far as St. Helen's Island nothing will be able to break this large extent of ice, and there will always be a free passage to allow the water to pass on the Boucherville side.

These islets would require to be small and low so as not to stop the ice in the spring. They should be built up on the rock mentioned above. The river is shallow at this place. It would be outside of the ship channel, and would in no wise obstruct navigation. The earth taken from the ship channel might be used for this purpose.

The Cost of these Works.

The first means suggested would only cost the good will of the harbor engineer.

The third means would cost little. It would be sufficient to dump a few barge loads of earth on spots selected beforehand.

Lastly, the second means, the excavation of the entrance and outlet of the Boucherville River would cost something, it is true; but I do not think it would cost more than the excavation of the *batture* of Longue Pointe.

Resumé.

I believe the inundations at Montreal and vicinity to be caused by the ice jamming on the *battures* of Longue Pointe and the Longueuil Islands, and on the *battures* of Pointe aux Trembles and the first island of Varennes. These jams are caused by the shoving of the ice which descends the St. Mary's current, and which is the principal cause of all the inundations.

And that the means of preventing them would be:

- 1st. To prevent the obstruction of the bed of the river by the earth excavated by the dredges;
- 2nd. To deepen the two extremities of the Boucherville River;
- 3rd. To form two or three small islets between Ile St. Joseph and the lower portion of the parish of Boucherville.

In terminating I must say I am greatly interested in seeing the end of these inundations, as all my property is situated in the Boucherville islands.

If your committee wishes for more ample information from me, I will have great pleasure to be at your service.

I have the honor to be your humble servant,

T. B. DE GROSBOIS.

BOUCHERVILLE, 15th February, 1884.

EVIDENCE OF ALDERMAN MOUNT.

Blaming the Clerk of the Weather.

Alderman Mount said he desired to explain his theory of the inundation of 1884. For about fourteen years he had been living at the foot of the current, and was in a position to notice the phenomena attending the river floods. He considered that the inundation had been caused by the manner in which the ice had formed this winter, which was quite different from other years. This winter the ice took first early in December, then eight or ten days' thaw ensued, when it was sometimes above and sometimes below freezing point. The ice then shoved down as far as Longue Pointe on to the shoals, and remained until it took a second time. During the mild weather, however, the snow or frazil packed and formed a barrier, which he considered was the cause of the inundation. About the 4th or 5th of January there was severe weather again, but the ice was not sufficiently strong to break up the barrier which had formed, and which was, in his opinion, the cause of the flood. Until the ice has reached what we call "les trois roches" it is said not to be firm; when the ice is strong it remains firm, and there cannot be any shove.

J. W. MOUNT, M. D.

EVIDENCE OF MR. P. W. ST. GEORGE, CITY SURVEYOR.

Recommending Scientific Investigation.

Mr. P. W. St. George, city surveyor, said that the plan submitted by Mr. Britain showing the level of the water in the river at the different dates, shows that on the 3rd January the water had risen four feet, and that there was no dam between this city and Longue Point. It was mentioned in the papers that Longueuil was not affected by the rise; but this was not so, as the water in Longueuil was at the same height as on the Hochelaga shore.

This year Mr. J. M. Nelson, assistant engineer of the Harbor Commissioners, has taken surveys and prepared plans from which valuable information could be had, and he would ask that these plans be submitted to the committee.

He would also recommend that engineers be appointed by the Government to investigate this ice phenomenon for a number of years as one could not form an opinion on one year's experience.

PERCIVAL W. ST. GEORGE.

EVIDENCE OF MR. ALFRED BRITAIN, ASSISTANT CITY SURVEYOR.

River Levels and the Water.

In 1869, I examined into the facts in connection with the rising of the river opposite the city in the months of January and April, with a view of determining the best location for the outfall of the city sewerage. It being an accepted fact that the rise of water in the harbor was caused by ice obstructions opposite or below the city, I confined my observations to this side of the river, and between Victoria Bridge and Longue Point.

The only records which I found available were: 1st. A report of the Royal Engineers in 1841, on the periodical flooding of Montreal; 2nd. The gauging of the

water on the lock sill at the entrance of the Lachine Canal. 3rd. Levels taken from Jacques Cartier Square to Handyside Creek, on the previous April, by Mr. Joseph Smith, who was at that time Deputy City Surveyor. I also saw several persons whose names were given me by Mr. Macquiston as being likely to have made useful observations on the subject.

The report of the Royal Engineers shows that these floods always existed, more or less, during January and April, and that their frequency and extent is less now than formerly. Plans also must have accompanied this report, but I found no traces of them; they would be of little service, as owing to the changes in the city since they were made their designs would be impracticable at the present date.

The daily record of the height of water at the entrance of the Lachine Canal affords no means of determining whether the height of water recorded was caused by the ice grounding opposite that portion of the city or lower down the river.

The levels taken by Mr. Smith in 1869, extending from Jacques Cartier Square to Longue Point, permit a profile of the surface of the river during flood to be made between those points, and was the only available record up to that date which showed the relative height of the river during flood; they give a fall of 4'33 between Ruisseau Migeon and Handyside Creek, and clearly show that a large jam of ice existed between those points. The flood water in the harbor was unusually high that spring, being two feet above the revetment wall at Jacques Cartier Square.

I took a series of levels during the winter of 1870; they are shown on the accompanying diagram. The first was taken on the 11th January when the water was at its highest point during that season, being one foot below the revetment wall, with a fall from thence to Longueuil ferry of 4'30; and from thence to Longue Point Church of 8'30. After remaining a few days at about that elevation the water went down, and the next rise took place in April. An examination of the accompanying diagram shows that a considerable change in the proportion of fall at the points of observation between Jacques Cartier Square and Longue Point took place; and that during the interval between January and April, obstructions had formed on the shoals in the neighborhood of Longue Point and from thence upwards. It also shows that the grounding of the ice on these lower shoals raised the water there several feet in height without causing a corresponding rise of water opposite the city, for on the 10th of April the water was within two feet of the top of the revetment wall and remained at the same height at that place until the 12th. During this interval of time great quantities of drift ice came down from Laprairie basin and by choking the channel raised the water about two feet, between Hochelaga and Longue Point, without making any change in its height opposite Jacques Cartier wharf.

From levels taken during this winter it appears that the fall of the water between Jacques Cartier Square and Longueuil Ferry varies from 2'00 to 2'4. If the rise of water opposite the city was caused by the accumulations of ice on the shoals lower down the river it would be shown by a corresponding reduction of the fall between these points, or in other words the rapid would be drowned out; but the diagram shows that such is not the case, because when the water is at its highest opposite Jacques Cartier Square there is an increased fall from thence to Longueuil Ferry.

I took corresponding levels in the succeeding year, 1871, they are recorded on the diagram in a similar manner to those taken in 1870 and confirm the conclusions arrived at from the levels taken the previous year.

The diagram submitted by the City Surveyor, Mr. St. George, shows in different colors the flood lines in 1869, 1870, 1871, 1883 and 1884; the January floods are shown by a firm line, and the April floods by a dotted line. In every case these lines show that the height of the water between Hochelaga and Longue Point is raised in the spring by the accumulation of ice between these points; without causing a corresponding rise of water opposite the city. This is very marked in the flood lines of 1870 and 1871.

Although I found no record of instrumental levels taken previous to 1869, the evidence of residents on the river bank demonstrated that in some cases an extensive dam had formed below Boucherville causing the village to be flooded. The levels

taken in 1867 clearly show a dam formed between Ruissou Magoon and Handyside Creek and the village of Longueuil was flooded by it.

The levels taken in 1870 and 1871 show the ice grounded all along the shoals from Longue Pointe to Hochelaga, but no special dam was formed. This year the levels taken by Mr. Nelson, assistant harbor engineer, clearly show that the principal dam is just below Longue Pointe Church.

From the above records it appears that the location of the ice dams is not uniform and that in some cases no special dam is formed between Boucherville and Hochelaga, although the ice always accumulates during the winter months on the shoals between these points and causes the water to rise there without causing a corresponding rise of water opposite the city.

The average fall of the river is less affected between Jacques Cartier wharf and Longueuil ferry than at any other part of the channel, as the depth and rapidity of the current between those points keep it free from drift ice and frazil. If the floods opposite the city were caused by the dams of ice below Hochelaga, St. Mary's current would be drowned out, but the levels taken show that it is not the case and that during floods the fall of water is greater in that current than during ordinary circumstances.

The evidence uniformly goes to demonstrate that the rise of water opposite the city is caused by a dam being formed on the shoals below the Victoria Bridge on the south side of the river. The old Grand Trunk wharf and Moffatt's Island form the nucleus of the dam, and it is rendered solid by the drift ice and frazil. That this wharf is a serious obstruction and diverts a large quantity of water into the north channel that would otherwise pass down the south channel there is little doubt. At ordinary summer level the water is from a foot to eighteen inches higher on the up side of the wharf than upon the down side, and during winter this becomes a solid dam and almost the whole volume of water, increased by frazil and drift ice, has to pass St. Helen's Island by the north channel.

That extensive ice dams occur above Moffatt's Island and raise the water opposite the entrance of the Lachine Canal is also shown by levels taken during the last two years to locate the position of an outfall sewer for Point St. Charles. These levels show that the fall of the river, from one hundred yards above Victoria Bridge to the entrance of the Lachine Canal is as follows, viz.:

When the river is at summer level the fall between these points is 8'0.

When the river is at flood level the fall between these points is 2'03".

These figures show that the natural fall of the water between these points is drowned out by the accumulation of drift ice and frazil, in precisely the same manner that it occurs between Longue Pointe and Hochelaga.

ALFRED BRITAIN.

MONTREAL, 27th March, 1884.

EVIDENCE OF MR. LOUIS LESAGE, SUPERINTENDENT MONTREAL WATER WORKS.

High Water Levels from 1853 to 1884.

Mr. Louis Lesage, Superintendent Montreal Water Works, had no plans to propose, but could make suggestions. He submitted a tabular statement of the high water levels from 1853 to 1884, taken at lower entrance of Lock No. 1, Lachine Canal.

The table showed twelve winter floods, of which seven were followed by spring floods, and one was yet uncertain. Of ten spring floods only three were not preceded by winter floods.

He further said that the obstruction in the channel was generally caused by the large quantity of ice shoving down on the shores of Longue Pointe and Varennes.

LOUIS LESAGE, *Superintendent of Water Works.*

Height of water above datum (M. W. W.) at lower entrance of Lock No. 1, Lachine Canal, at flood times:

Year.	Harbor Closed.	December.	January.	March.	April.	Harbor Opened.
1853		—0.5	16.3			
1854	Dec. 6	—1.1	18.9			April 25
1856	3	—1.11	20.6		17.9	24
1858	12	—0.10	18.3		17.6	9
1859	11	1.3	17.5	17.5		4
1861	22	1.0	17.4		22.7	24
1862	7	—0.4	17.6		16.5	23
1863	12	—0.3			17.9	25
1864	11	1.4	18.0			18
1865	16	—2.4	17.10		21.9	10
1867	6	—2.5	18.8			22
1869	6	—0.6			21.5	25
1870	18	—1.4	17.6		17.6	18
1873	Nov. 26	1.8			19.6	25
1883		16.10				
1884			19.0			

*This went up to 21.7.

Top of revetment wall at Jacques Cartier Square is 19.6.

The above table shows twelve winter floods of which seven were followed by spring floods and one is yet uncertain. It shows ten spring floods only three of which were not preceded by winter floods.

LOUIS LESAGE, Superintendent of Water Works.

EVIDENCE OF MR. LEGER, PILOT.

Build two Rows of Piers above Lachine Rapids.

Material, plates, No. 24, 6 feet long, 4 feet wide, by $\frac{3}{4}$ thick, would cost \$147. Making and fitting on plates would cost \$147. Would require 260 pounds of $\frac{1}{2}$ inch rag bolts 6 inches long, to secure the plates, which would cost 7c. per lb., which would make the sum of \$17.50, which would form total of \$311.00.

Estimation of Cost of Piers.

6 piers, 100 feet square, 15 feet high, requiring 13,000 feet each of flat and square hemlock, 78,000 feet at 10c. per foot.....	\$ 78,000
610 toises stone per pier, 3,810 toises at \$6.....	22,040
Workmanship of 78,000 feet timber at 4c. per foot.....	3,120
	<hr/>
	\$ 33,960

Mr. Michel Leger, one of the pilots of the upper lakes, was examined, and displayed a plan to the committee. His opinion was that floods could be obviated by the erection of piers and booms at outlets of the lakes, especially at the outlet of Lake St. Louis, which would stop the ice in its course and leave a passage for the frasil.

by
CHARLES X LEGER,
mark

Mr. Michel Leger continued his information to the committee. As he thought that the plan which he submitted at the last meeting was not fully comprehensible he would give further details about it. In Lake St. Francis the ice generally broke up about fifteen days after that at Montreal. The consequent shove caused a dam below the city, which was quite impervious. He proposed the construction of two rows of piers or booms, one from Ile Dorval to St. Nicholas, and another just above the Lachine Rapids. In reply to a question by the chairman, he said he had not prepared an estimation of the cost of such construction, but would do so for the next meeting.

his
 CHARLES X LEGER,
 mark

Witness—A. GOSSELIN.

EVIDENCE OF MR. G. H. HENSHAW, CIVIL ENGINEER.

Widen the ship channel at Longue Pointe, open a new channel at Boucherville and clear the channel south of St. Helen's Island.

Mr. Henshaw said that he had always been proud of Montreal, and always tried to do some good to it. He had always had the idea that something might be done towards making the harbor of Montreal a winter port. His opinion was that we could have a harbor in which vessels could be protected from ice. He had had a good deal of information, and he thought that a great deal of credit was due to the city of Montreal for ascertaining certain facts in this matter, and he hoped that the theory which he would presently give would accord with the facts that had been brought up by our engineers.

One of the most important pieces of evidence, which he had heard so far, was that of Mr. de Grosbois, which did certainly reflect much credit on that gentleman, and he agreed with him in what he had said.

MONTREAL, 24th January, 1884.

Geologists tell us that the valley of the St. Lawrence, in fact the great interior of the continent was in past ages a great basin which has been by turns repeatedly depressed and elevated, the successive stratifications at present existing therein, being deposited during each submergence, from material eroded from its shores and highlands. This erosion, speaking in general terms, produced in the course of the last of these changes the alluvial soil which at this moment covers the valley of the river, and through which it has cut its present course.

Referring to the particular part of the river which at present demands our attention, that is, between the Lachine rapids and the foot of the island of Montreal, you will perceive that as the river excavated its bed and shrank to within its present shores, numerous islands came into existence. These islands were formed by the presence of obstructions which made it easier for the stream to cut its way on both sides of them than to carry them off, that is to say, the river followed what is called the law of least resistance, according to which the stream first divided at the head, and then became again united at the foot as soon as that law permitted. Here, at the heads of Heron and Nun's Islands you can see the groups of boulders which remain of the original barrier which produced these islands, also the small island and ledges above St. Helen's, &c.

Looking at the conformation of this part of the river there can be little doubt that before the shore line took its present shape, its main channel ran in a direction more conformable with its general sweep than it now does; thus, with its north shore about the same as at present, it flowed at a comparatively even width throughout, its main body taking the south or rather east channel at St. Helen's Island until it reached Longue Pointe, then not so defined, but more rounded like Pointe aux Trembles, below which there appears little reason for supposing any material change. The north channel at St. Helen's Island would be small, and very likely at first discharged nearly all its waters through the passage between St. Helen's and Ile Ronde.

At this period all the islands now seen, and perhaps more, were in existence, and beyond some reduction in size from wearing away by the stream, present the same appearance to-day, except in one very notable instance to which I shall presently refer.

As the river continued to cut its way, always choosing the softest places consistent with the correlation of its forces, it began gradually to excavate here, on the outer side of its curve, the Laprairie bay, and as a consequence of the change of curves so produced, began to hollow out the north or west channel, known as the St. Mary's current, as well as the bays now composing the harbors of Montreal and Hochelaga, a process much aided by the bars of rock which impeded the natural deepening of the other channel; the absence of which indeed might have prevented the formation of the north channel at all. Thus we see that this new curve, worn along the Hochelaga shore, is really what has made what we call "Longue Pointe," this being the place where the two currents running side by side fairly resume a united course.

Now I wish to draw your attention to the remarkably exceptional character of one group among all these islands, to which I have alluded, namely the Boucherville Islands.

If you have attentively followed, and admit my reasoning so far, I think you will also agree with me in considering that, originally, these islands were united as one, having the same general oval form as all the rest, and that as the north channel began to monopolize the volume of the river and rushed to its junction with the other off Longue Pointe, the latter was thrust more upon this island, forming first a bay and finally a channel separating one part from the other. This channel, on account of its current being reduced in speed, would, at its lower end, separate into several small passages forming all these small islands. You see they all partake of the same general form with the rest. But this is not all. You perceive that the main island is traversed by several small channels or rivulets absolutely at right angles with the course of the river, dividing it up into pieces, much as a cook would divide a long fish for frying; and here I think in these apparently insignificant water ways we will find the solution of the main difficulty, if not of the whole question.

Between these islands and the south shore there is a narrow channel navigable to vessels of small draught, the whole lying well out of the line of the main current of the river. Now surely it might be expected that these narrow passages, and even the channel along the shore, lying as they do in a sort of eddy would silt up; and yet there is no tradition that I know of, of their ever having been different from what they now are. The names of the islands have existed from very early times, and though the passages have been long encumbered with grass and sedge they have never been closed. It is therefore to the condition of their formation that we must look, to explain their preservation; and to do this we will first look briefly at another question, namely, the formation of what is called *frasil ice*.

This question, upon which a great deal has been said and written, I would like very much to take up at length, but at present it would take us too far from our subject. I will therefore only say that what I have every reason to believe is the true theory, one which I may be pardoned for looking upon with some satisfaction as being my own, is this, as applied to this special locality:—

In very cold weather the water passing down the Lachine Rapids, becomes practically reduced in temperature below freezing point, and passing beneath the slower moving waters at their foot, quickly refrigerates the stones and boulders spread over the bottom of the great area below, converting it into a veritable nursery for the production of *frasil ice*. There is plenty of evidence of this latter fact, which I will not now stay to give. The *frasil* thus formed is continually being broken off in small quantities and floated down, but when a sudden thaw occurs, it detaches itself in large masses like heaps of gigantic icy bars, and floats down until it finds a place shallow enough to hold it between the under surface of the ice and the bottom, where it stays and is packed in, and extended by succeeding masses, until the water way is so narrowed as to cause a more or less sudden rise of water.

The fluctuations or partial falls, that follow rises, are due to the breaking away of parts of these dams when lifted by the rise.

Thus we may fairly assume that frasil ice is the immediate cause of the rise of the river in winter, for it is only in the breaking up of the river in spring that masses of ice at all capable of blocking such a channel are on the move. This choking of the river by frasil ice is of yearly occurrence, for there is always more or less of rise, therefore it is only when the conditions are most favorable for the production of this substance that a flood occurs. Again, so long as the normal course of the stream is not interfered with, there will be little difference of locality in the deposit, but only of quantity. One other fact, we are apt to lose sight of, must be borne steadily in mind, and that is, that the volume of the river in winter, except in heavy thaws, scarcely ever surpasses that of low water in summer. This is important to remember because it is this lowness of the water which narrows the space between the surface ice and the bottom. Hence the lower the water at the beginning, the more rapid and extensive is the formation of the dam, if all other conditions are the same.

Bearing all this in mind, let us see what course the frasil ice once in motion will take. The south channel being shallow and obstructed would attract but little and the mass would be carried by the current directly down against the city, and, depositing its quota among the wharves, it would sweep along the Hochelaga shore towards Longue Pointe. A small portion would be attracted by the current between St. Helen's Island and Ile Ronde, but the proportion of this would be so small, that the removal of this latter island, so strongly advocated by some, would not probably make a noticeable difference. Arrived at Longue Pointe it would shoot out a talus in the direction of the shoal at that place, across the main channel, and towards the opening in the Boucherville Islands. Immediately the river would begin to rise, in proportion to the obstruction formed, until the force of the current became sufficient to break off or deflect the end of the talus and carry away the surplus frasil, to lodge among the islands below.

The river by this time has risen enough to enable a considerable quantity of frasil from above to descend the south channel, following of course its deepest part, and obstructing the shoal in front of Longueuil, until opposite Longue Pointe, it is thrust aside by the main northern current and fills up the channel or cul-de-sac between the Boucherville Islands, practically confining the whole volume of the river to the present ship channel.

And now we come to the explanation of these small lateral passages which so curiously divide the Boucherville Islands. The confined water of the main channel rises considerably higher than that of the narrow channel along the south shore, and hence in escaping beneath the ice, these little channels have been cut. Thus these channels are winter torn and are not silted up in the summer because every winter they are washed out by the same agency that originally produced them.

This then is my theory of the cause of the winter floods which affect the city of Montreal, based upon my investigations into the character of frasil ice and its effects; and I pretty confidently expect that the result of the examinations undertaken by the city and harbor engineers, now in progress, will confirm it in every important point.

The Remedy.

Assuming my theory to be correct, I would confidently recommend:

1st. Widening the ship channel at Longue Pointe by cutting the flanking shoal entirely away, close up to the shore, and so straightening as well as widening the channel.

2nd. The conversion of the cul-de-sac in the Boucherville Islands into a channel of relief, by giving an exit below.

3rd. Removing Moffat's Island and clearing the south channel of all large boulders and projecting rock ledges

All this would not, of course, prevent the formation of frasil ice, but it will remove it to a safe distance; and for the same reason, very largely diminish chances of ice jams in the spring, if not entirely remove them.

It would be as idle to attempt the entire prevention of rises in the river as to do away with the ebb and flow of the tide; but we may reasonably expect to be able to keep these rises from becoming floods.

I would add in reference to my third recommendation, that the excavation of the south channel at St. Helen's Island to a depth sufficient for the river traffic in the summer, would be still more effective, and I confidently predict that this will some day be done, but unless it is made part of a more comprehensive scheme of harbor improvement, it is not to be recommended, since, by itself, it would have the effect of lowering the harbor level during the dry summer season, which also means a reduction of depth upon the lower sill of the canal lock.

GEORGE H. HENSHAW, C.E.

EVIDENCE OF MR. JOHN KENNEDY, HARBOR ENGINEER.

Mr. John Kennedy, Chief Engineer of the Harbor Commissioners, produced a number of charts and maps showing accumulations of ice at various points in the channel, depth and width, taken at times of flood.

He explained that the flood of last fall at Montreal was caused by a general diminution of the capacity of the channel from the Victoria Bridge to below Longue-Pointe and not by an ice jam forming a dam at any definite point. Levels taken during the flood show only about a foot of backing up of the river at the large ice jam at Longue-Pointe, but from that to the bridge there was a gradual increase of the surface inclination to an average of about 20 inches per mile, as against 6 inches per mile in summer. A coating of frasil ice on the bottom and accumulations under the surface ice might easily increase the surface slope of the water, say an inch per mile, and even this little increase extended for miles would have a very marked effect on the water level. Add to this solid accumulations or jams at various points, still further reducing the channel and increasing the slope, and floods are easily accounted for at Montreal.

Floods occur at many points between Cornwall and Quebec, as well as at Montreal; at Cape la Roche, for instance, the water rises in such a way as sometimes to flood Batiscan. Three Rivers is also flooded every five years. Ice jams are frequent at Cornwall, and the water powers of the large factories and mills there are sometimes drowned out all winter. From these facts it may be gathered that the ice accumulates every place where a rapid current changes to a slow one, and that it often jams in such a way as to increase the hydraulic inclination more or less abruptly, and thereby causes a flood.

In the case of Montreal it is well known that the ice "takes" first at the Boucherville Islands, and the river from that to Lachine is open much later. If the frost is very severe during that time, floating ice and frasil are formed very fast in the open water of the Lachine Rapids and Laprairie Basin, and these are floated down to the stationary ice till the whole harbor is not only covered with packed ice, but immense quantities are carried under until the area of the channel is greatly reduced. The combined effect of the friction of the surface ice and the choking up of the channel beneath is to increase the surface slope of the river, from about the Boucherville Islands to the city, to a greater or less extent, and in some years to such extent as to flood the lower streets. The recorded levels and careful observations are few and incomplete, but so far as they go, they show that floods are due to this gradual rise over a considerable distance, and not to the ice jams which appear so formidable upon the surface.

In 1862, at the time of the flood, levels of the water in the river were taken by the Road Department which he thought were still on record in the Road Department.

He was of opinion that frasil forms everywhere in open water and extreme cold weather, whether the water be in rapid motion or otherwise. He is not aware of

any remedial measures yet proposed which could be relied upon to prevent floods. The dredging hitherto done had made only an insignificant ditch in the bed of the river as compared with its whole enormous volume. There are no local obstructions in the river at Montreal by the removal of which we could hope to entirely relieve Montreal.

The building of piers at the foot of Lakes St. Francis and St. Louis might do some good, but would not affect the general question.

Mr. John Kennedy, harbor engineer, continued his evidence as to the nature and extent of the several inundations which had occurred during the last twenty years, and although not now prepared to offer any suggestions for the prevention of floods in future, was of opinion that they could be at least mitigated. The information as to the important facts and conditions which accompany floods are so meagre and fragmentary that it would be unwise to base a scheme of prevention upon it. He strongly advocated a comprehensive series of observations and survey of the river from Varennes to Lake St. Louis, for the purpose of obtaining full and accurate information as to all the facts accompanying floods. This could only be done at considerable expense, but it is the first essential step towards dealing with this important question.

Mr. Kennedy in reply to a question of the Chairman said he thought that if the main channel about the Boucherville Islands were widened and straightened it would be better, or at least in the right direction. He could not say what this would cost without further surveys. The probable cost of making the surveys between the city and the Boucherville Islands would be about \$500, after which the cost of widening and deepening the channel could be very easily determined.

Mr. Cramp asked how long it would take to make a survey; to which Mr. Kennedy replied that in summer a survey could be made in about a month's time.

In reply to a question by Mr. Jones, Mr. Kennedy said some of the pieces of ice which pass through the harbor are very large and some very small. Some of the pieces were so large that it was puzzling to know how they could pass under the Victoria Bridge. He did not think that the construction of another bridge would do any real good towards protecting the city from floods.

JOHN KENNEDY.

MONTREAL, 3rd April, 1884.

To the Chairman of the Flood Committee.

DEAR SIR,—I desire to record the following remarks in reply to the opinions expressed by the harbor engineer at your meeting on Tuesday last, which the lateness of the hour prevented my making on that occasion.

It is neither reasonable to expect, nor to be desired, that Mr. Kennedy, occupying as he does so important an official position in relation to the subject, should be other than extremely cautious in either adopting or condemning views which further investigation may or may not prove to be erroneous or inadequate. I therefore take his remarks to be rather the expressions of his present impressions than the result of settled conviction.

I entirely agree with him as to the actual facts presented by him. There can be no question that the river is high from one end to the other, and that floods take place at other points beside Montreal; but the present question does not concern them, neither is there any doubt as to the very slight winter variations in the hydraulic slope of the river, observed during floods; but this fact, taken only by itself, constitutes no argument, or rather might reduce it to the absurd alternative that there either could never be a flood, or that there must always be a flood. Of course Mr. Kennedy does not mean this, and I mention it only for the benefit of those not well acquainted with technicalities. If, however, it is his opinion that the whole river would have to be treated in order to remove floods from Montreal, then I cannot agree with him. The hydraulic slope of the river is composed of many various slopes, due each to the nature of the obstructions encountered, and is an average of

all. I hold it, therefore, quite possible to materially alter the slope at one spot, without at all affecting the general hydraulic slope of the whole. In fact it is a natural alteration of this kind, though in an opposite direction to that desired, that has caused the flood.

Again, no doubt, in summer the ship channel, as Mr. Kennedy says, is but a scratch in the bed of the St. Lawrence, but to my mind in winter its relative importance is vastly increased, since, judging from the few cross-sections taken, it, together with one or more of the natural channels, constitutes at certain places the sole outlet for the volume of the river, and consequently has to make up in height what it lacks in width; unless, therefore it can be shown that there is no larger area below the obstruction than at it, I can see no valid reason against enlarging the opening at the obstruction. Whatever possible difference there may be between Mr. Kennedy's opinions and mine, I think at least he will agree with me in this: that, considering the statements made as to the coincidence of floods with certain dams of ice, by Mr. Gr. sbois and others, the public will be scarcely satisfied until such examinations are made as will prove or disprove their agency in causing floods in the city.

I may add that the facts adduced, so far, by the investigation, have produced a strong impression in my mind that we have narrowly escaped perhaps the heaviest spring flood that has ever visited our city. Had the late unusual thaw of ten days and nights been extended a few days longer, a movement of the ice of a very dangerous character must have taken place. This has, however, happily been averted until the ice has become so rotten as no longer to be capable of adhesion in large masses; but the lesson it teaches is certainly not to fold our hands with the Turk, and cry Kismet; it is fate.

I remain, dear sir, your very obedient servant,

GEORGE H. HENSHAW.

Mr. LOUIS ST. DENIS, of the city of Montreal, testified as follows:—

I am a pilot and am well acquainted with the St. Lawrence and Ottawa Rivers. I would recommend, in order to prevent future inundation, that piers should be built across the Chateauguay shore from the south to the north channel, so as to retain the ice there and keep it from choking the river lower down.

The piers could be built on the shoals where the water is not more than three feet in some places and a little more in other places. A part of the work can be done this winter. For further reference I would refer you to my plan. I am well recommended by several marine inspectors.

LOUIS ST. DENIS.

EVIDENCE OF MR. J. M. NELSON, ASSISTANT HARBOR ENGINEER.

Dynamite Useless.

Mr. J. M. Nelson stated that there was a difference of only four inches in the level of the water between Longueuil and Hochelaga on the 3rd January last. Between Montreal and the latter point there was a fall of three feet four inches, which was a little more than normal, the fall in summer being two feet three inches.

The south channel was nearly blocked up this year, there being no current to speak of and the water was forced down St. Helen's Island, and passed down in the north channel or opposite the city.

The jam at Boucherville was over two miles in length and one mile in breadth. He considered the idea of blowing it up with dynamite was almost impracticable, and would have little or no effect, as it consisted of cakes of ice at the top and frasil below, and with a brittle, yielding substance like this, dynamite having no resistance, it could not do much good. If the dam was blown up it could jam lower down.

J. M. NELSON.

PLANTAGENET SPRINGS, ONT., 27th April, 1886.

To His Worship the Mayor, the Aldermen and the Citizens of Montreal:

GENTLEMEN,—I herewith address to you a paper written by me on the important subject of the flooding of the city of Montreal and its environs. Were it not for the loss of my flood notes, reports, &c., which I had kept for many years, and which were being in use by the late City Surveyor, I might have made this paper of more value as to precise details.

As it is, I have thrown together some particulars and explanations from memory. I have added thereto such remarks, opinions and suggestions as, in my humble opinion, the importance of the subject merits.

Had I remained in the council it would have been my duty to make use of the preparation made for it.

If I have failed to afford sufficient explanation on any part of the subject which it may be in my power to extend; it is only necessary to call on me to do so.

I am, gentlemen, yours very respectfully,
WM. RODDEN.

Ice Shoves and Montreal Floods.

This subject is now and has been one of the most important before the city of Montreal. It is a subject that has received much attention during the last half century. The loss and damage suffered by the people during that time must have exceeded the amount it would have cost to have placed the streets that are below high water mark, sufficiently high to enable the people to use them without interruption, and assist in furnishing a partial remedy.

Many years ago the corporation fixed upon a higher level for flooded streets, and have done much, particularly in St. Ann's Ward, to raise them, some parts of which have received as much as four to eight, ten and twelve feet of filling. It is true there remains much to be done to finish that part of the required work, and it should be very well understood that raising the streets is not all that is needed to save citizens from periodical flooding of their premises.

The people naturally look to their representatives in council to consider and adopt measures of relief, and also should look to their representatives in Parliament to consider whether or not the causes are outside the boundaries of the municipality of Montreal, and they should come to the assistance of the city corporation in obtaining the performance of what is needed to be done on the river and harbor works outside of the limits of the city's control, and obtain legislation for the corporation, giving powers to do their part of the work without liability for damages.

The great efforts made to keep down taxes, the desire of members representing other sections of the city to obtain all they can from the city treasury to improve their sections, have often made it difficult to obtain suitable expenditures on the flooded section of the city, which are the outlets for the trade of the city to its harbor, the canal and railway stations. It would be out of place for me here to give particulars of the persistent efforts of members of council representing the flooded sections to secure a full share of attention, nor is it necessary I should speak of what was done in my time of membership—the work done speaks for itself; if more was not accomplished it was due to the magnitude of the required work, the impossibility of reconciling the different opinions on the causes of flooding to justify entering upon a full and perfect system of relief, and the difficulty of bringing together all the interests outside of the city limits that sooner or later must participate in the expense of the necessary work and its benefits.

I can well understand the difficulties of the position of an alderman, particularly if he had much business of his own to look after, while he is at work on extensive and troublesome municipal questions, and if at all zealous in the performance of public duties, his own interests are damaged, unless he is more fortunate than is usual in having about him persons thoroughly reliable.

Then again, an alderman is surrounded by a multiplicity of persons interested in smaller questions turning up from day to day, pressed upon him by electors, each often unwilling to look at any subject excepting as it troubles or benefits himself. Thus the aldermen are subject to great trials, hindered often from full study of great questions, and eventually either become disgusted with the humiliating position and retire, or take an independent stand in what they consider right, and have all sorts of unjust motives heaped upon them till they feel it impossible longer to continue the connection, and leave the work they were engaged in to be longer delayed or to fall into the hands of persons unwilling or unable to give the necessary time and study to the task.

Feeling as I do the full force of the foregoing expressions, I have no difficulty in understanding now that the death or removal of a civic officer and the retiring of aldermen who labored on such important questions may to some extent account for delays, particularly when it is considered that the great majority of the council represent other sections of the city claiming their attention. These considerations have led me to the conclusion that the city council might appoint a commission with the mayor and chairman of finance *ex-officio* members, who, with the assistance of a first-class engineer of experience in this country, acquainted with the action of the ice and the floods, could take all necessary means to consider, report upon, and eventually carry out whatever work the city council might determine to be necessary to be performed within their jurisdiction.

The Government and the Harbor Commissioners as well as adjoining municipalities, are also so largely interested in this question, it is important that co-operation be secured from them.

Any legislation necessary should be at once obtained, that the city may have full powers to act in the adoption of such works as may be found necessary, and that the proposed works may be done without the city being exposed to liability for damages for their performance.

Following the foregoing introduction of the subject, it may be proper to explain that the writer was too young to observe the action of the ice and floods previous to the floods of 1837-38 and of the following spring. I well remember that our shop in St. Paul Street and others adjoining were flooded, ice was piled along the river banks, buildings there were injured, the present site of St. Ann's Market thence to the river was an open creek which extended to St. Joseph suburbs, the old Montreal College was surrounded with water as if standing in a lake, extending round to Craig Street, that was then an open creek, overflowing its banks from Fortification Lane to Jurors Street.

Skaters resorted to the open creek at the foot of McGill Street which overflowed St. Paul Street, Point à Calière, and thence to the Lower Lachine Road, along the valley to near the Fraser Farm, and extending also to the lowlands of Cote St. Paul, and from the canal along the lowlands near the Upper Lachine road banks, continuing through to Bonaventure and Craig Streets.

The winter flood of 1837-38 was remarkable for its height and extent, during very cold weather. Much loss and damage occurred, property on the river banks was injured, and there was great suffering by the people flooded. Very little assistance could be taken to them till the ice was so frozen that sleds could be taken by hand, and skaters could travel from St. Paul Street near the old market, now Custom House Square, to Lower Lachine around to Bonaventure and Craig Streets, and on the way look into flooded houses from the second floor windows. So great was the outcry on this occasion, and some time after it, that the Commission of Royal Engineers was ordered to investigate and report upon the causes, and the remedies.

Their report was presented in 1841. I was a clerk in St. Paul Street at the time and remember adding to my flood notes that I commenced in 1837-38, the expressions of old citizens, disapproving the report of engineers, and contending that the ice dams that formed in front of the city were not the only or continued cause of floods; that floods had also been caused by ice shoves that occurred far below the city and far above it.

On one of those occasions of general floods, the roar and crashing of descending ice brought out St. Paul Street merchants to view the immense fields of ice evidently from the upper lakes, passing down below the city. Piles could be seen as far as the eye could discern, evidently grounded on shoals as far as Boucherville or beyond it.

I remember well the cluster of merchant neighbors viewing the magnificent but terrible crushing and piling fields of ice, while they laughed at the idea of \$90,000 to \$100,000 being of much service, and asked one another how many millions of dollars would it take to afford permanent relief. There stood within my hearing such men as the late John Torrance, John Frothingham, Jacob Dawitt, Horatio Gates, Wm. Lyman, Esquires, and others, then as well known. In St. Paul Street many stores and shop floors were again flooded, and many goods damaged. I continued to follow enquiry into the periodical cause and effect of such magnificent yet dangerous spectacles, and I gave attention to the remedies suggested. Those great floods were not confined to Montreal. The changing features of ice jams and floods has been such that, within the twelve months, notes have been taken of shoves and floods that at intervals operated upon every low-lying section of country from Sorel to Beauharnois, extending thence across the Lake to Isle Perrot and St. Ann's. Such extensive floods as the one here referred to were preceded by low waters in the river during the time the ice formed that fall and winter.

The early part of the winter was very cold, accompanied by very light snow falls, and the ice on rivers and lakes formed very thick. In the early part of March mild weather and rain converted the snow on the ice into water, and weakened the ice much more on the upper lakes than upon Lake St. Louis and the harbor; some ice from above that lake came down to the shoals near Beauharnois, causing higher water above. Frost set in on the third night of the thaw; the following morning travelling on the river to Beauharnois, from Point Claire was resumed, and I spent that day on the road along the river through Lower Laachine, Point Claire to Isle Perrot, thence across through Beauharnois to St. Timothé and back to the city, doing 75 miles, and as I passed along I viewed each point of interest, which produced a conviction in my mind that the spring flood would be serious and widespread, inasmuch as the ice from Beauharnois was very strong, while that on the lakes above was reported to be much damaged by the thaw, and likely to come down earlier than usual.

The shoals in the narrows above St. Ann's look were covered by ice jams, the water above was much raised, for several days it was dangerous getting on and off the ice there. Early in April the thaw set in, part of the lake ice increased the jam at St. Ann's and it was very little of the water from the Ottawa passed that point, it passed for some time in the Back River channel. That thaw broke up the ice on the upper lakes, rising of the waters in the channels brought it down, till it came in contact with the jams on the shoals between Laachine and Beauharnois, and there increased the obstruction which held back the water, flooded that town, Chateauguay, part of Isle Perrot, St. Ann's and Point Claire, and obstructed travel on the land roads till the height of water increased enough to lift the ice jams from the shoals and carry the fields of ice down to the shoals between the Victoria Bridge and the Laachine Rapids.

There a large portion of it remained for a time, backing the flood upon the south shore of the river, and extending beyond and above Laprairie, also on all low places of Lower Laachine Road, and the flood came into the city through the drainage outlets under the Laachine Canal, and poured rapidly down William Street to St. Paul Street, and down Bonaventure Street to Craig Street.

While thus the city was being flooded from the west, the water was also operating upon the ice jams, eventually carrying them past the Victoria Bridge into contact with the ice in front of and below the city. The contest between the yet strong ice below, and the very large quantities from above was one of the most grand and terrific scenes of the kind ever witnessed. Mountains of ice were piled up on the river banks as far down as Dalhousie Canadian Pacific Railway station, and across

to St. Helen's and St. Lambert. Had not the island been the stopping place the village of Longueuil would have been destroyed. This stoppage threw the flood for a time back on the city till it reached sufficient height to raise the ice jam and divide the flow of waters to both sides of St. Helen's carrying the flood to parts of Hochelaga, and to all the south shore on to below Boucherville Islands. The river craft wintering there were injured, and the population all along suffered. While this was going on, the ice from the Ottawa was on its way down, a great part passing by the Back River to meet the St. Lawrence ice below the Montreal Island, and both joined passing downwards. At Sorel they met the ice from the Richelieu, did much damage to the river craft and wharves there, and flooded the place. On this occasion the Montreal flood stood at a great height till the breaking up of the ice at Sorel, which came from the St. Lawrence, the Ottawa and the Richelieu.

We may here ask what kind of piers could have been placed in the river to hold the ice above the Victoria Bridge, or above Lachine, and what would they have cost? That if the ice was held there how much of the country above the piers would have been flooded, and who would pay the people that suffered damage?

In the foregoing I have described as brief as possible what occurred during a general flood on one occasion. Fortunately such extensive and far-reaching effects of the river obstructions are of rare occurrence; they are such as to tax the ingenuity of the highest engineering talent, to fully understand and demonstrate thoroughly perfect remedies to obviate the difficulties all along the line.

The question now naturally suggests itself, what has the general flood to teach us in connection with what suffering Montreal endures from floods?

1st. There is no difficulty in arriving at the conclusion that we cannot control the action of the ice in its departure and onward course, or, in other words, keep it from coming down upon us without expending a large sum of money, and if authority was obtained from Parliament it would cause the city to be liable for all damages that might arise to the people and their property that would be in any way injured thereby.

2nd. That even if this could be done there is not any assurance of perfect relief from floods by that means, owing to the nature of the channel from the city front downwards and its liability to become obstructed at some of the shoals below the city, when all the ice below the piers would collect, and with frasil forming at different points that would be carried down to the place of obstruction, and there cause contraction that would not admit of the passage of the great volume of water that would come down the St. Lawrence and Ottawa rivers each season that the thaw or rains would set in from the west and south much earlier than they do from the district of Montreal downwards.

Having explained my experience and information of a general flood extending over a distance of about sixty miles, over twenty of which are above the city, I will now explain a few of the inundations and their causes that have occurred in my time, producing the greatest damage to Montreal and its adjoining municipalities. I have observed at least six different places that the ice has formed dams by being shoved and piled in as many different forms at different times.

The effect of each one of these was to hold back the flood upon the city till the necessary head of water was produced to lift the ice out of the way. This convinced me that the removal of the obstructions in the channel from below Lachine Rapids to Bout de l'Isle, would have to be considered in the general plan of river works, should such works be intended as a perfect remedy. Yet it would be possible to afford partial relief by performing the most important of the river works, which if carried out, would facilitate the adoption of city works, with less disturbance of existing drainage, and less expensive surface works.

The six places referred to may be described as follows:—

1st. The shoals above the Victoria Bridge. When the ice forms there and is added to by ice at times descending from the shoals above, while ice below the bridge remains firm, then the accumulations above remain firm, reduce the water way, and an early thaw above brings down ice as well as water, and thus increases the ice jam

and the flood, which I have seen operate in two ways : once the ice was driven to the height of about sixteen feet over the south embankment of the Victoria Bridge, on another occasion the ice was piled on the banks at the south-west side of the bridge ; one caused greater flood on the south of the river from St. Lambert to Laprairie till the channel opened near the city, the other sent the flood to Lower Lachine, letting it into the city by the low lands of River St. Pierre and Point St. Charles, thence into the city at William Street, St. Joseph Street and Bonaventure Street West.

2nd. The harbor shoals. When the ice forms there to a great strength and water is low, the ice from the Victoria Bridge shoves to it and piles on those shoals till it reaches the St. Lambert wharf and south banks of the river there ; eventually it closes the water-way till the water lifts the ice. On some occasions the greatest weight of ice will be forced to a great height on the city side, then the channel will first open on the south side of St. Helen's Island, making an opening on the Longueuil side and causing a great flood there ; on other occasions the strongest and greatest body of ice will form on the St. Lambert wharf and south channel, then the harbor and city will suffer most from the flood, till it lifts the ice between the city and the islands. The shove in that case is carried to the shoals below the islands and eventually spreads towards Longueuil till it again rests upon shoals, or, by force of the water, is carried on till the accumulation so increases as to form another dam, above or below Longueuil, as the case may be.

3rd. The shoals and Isle Ronde between Hochelaga and Longueuil. When the ice forms above Victoria Bridge and from Lachine upwards before the harbor ice is firm, the ice has also become firm on those shoals below St. Helen's Island. A change of weather and of wind has sent the harbor ice with some from above, down the current to those shoals till they become packed and form a dam, which gains additional strength by ice descending to it backing the waters up to flood the city till again forced onwards down the river, or into larger piles on shoals below Longueuil, or is so broken up as to open the channel.

4th. The shoals from Hochelaga and below to Longue Pointe across the river and from Longueuil down the same distance on the south side.

When the ice forms first and firmly here and below, and the ice continues to descend in moderate quantities, it packs and fills the channel, touching all downward obstructions in the river and gradually raises the water, still filling as it receives the descending ice, till a cold night or two adds to the strength, and a dam is found flooding all above it till the water lifts the ice and clears the channel.

5th. The shoals from Longue Pointe downwards across the river to south shore.

It has occurred that the same operation as is above described takes place here with the same effect. Frequently the effect is prolonged by the descending ice continuing to pack on the shoals upwards till St. Helen's Island is reached ; lake ice coming down at times keeps up the supply till the whole river is filled from Victoria Bridge down to the Longue Pointe ice jam, thus the fact of so many miles of ice packed from that place or below it to the city, makes it more difficult to remove or lift, consequently the greater the flood and the longer period it must continue till the force of the water moves it down, sometimes only to pile it up again in some other place below.

6. The shoals from Bout de l'Isle extending to Boucherville Island and the junction of the St. Lawrence and Ottawa Rivers downwards.

In this place, ice of the St. Lawrence and the Ottawa at times meet. If the ice below the place of meeting is strong and packed the coming ice adds to its piles, creates a jam which extends upwards, as in previous cases is explained ; on some occasions it makes the complication more serious and extensive, creating a flood of long or short duration, according to the weather, the strength of the ice below, and the quantity arriving from the lakes above.

Thus far I have endeavored to show in a rough way what I have seen different times at these places of the action of the ice and the waters of the river, and how they combine to produce the floods that cause so much loss to Montreal and adjoining municipalities. I have explained how a general flood is produced. One of those

floods was very alarming and injurious; two or three others such occurring in my time were not so far reaching or destructive. One such occurring in mid winter would be most serious. It is fortunate that cold set in to check the thaw and rainfall this year, or Montreal would have suffered dreadfully; too much occurred as it was.

One of the great dangers lies in a thaw setting in with rainfalls west and south of Montreal, while the ice at and below the city is strong, and resists being moved down by the coming ice from above. About one out of every five floods has been a general flood, extending below and above Montreal, and about one in three Montreal has become the chief sufferer. Next examine what has been done to remedy flooding.

After the great flood of 1837-38 the Government ordered an examination and report from the Royal Engineers. In 1841 it was made. From it we learn that their attention was confined to a section of the river not high enough up, nor sufficiently low down the river. Evidently they were not aware of the extent and location of the several shoals upon which ice piled, or, if they were, they did not consider them of importance. The substance of their report suggests their unwillingness to recommend any important work upon the river, although they mention "leaving it for future consideration."

They recommend works to raise the revetment wall, change the course of the River St. Pierre, close all culverts and drains, draw off the city streams to a lower level, and outside waters to be drained by Craig Street—all at an estimated expenditure of about \$94,000.

When I entered the city council as representative of St. Ann's Ward, I continued investigating this subject, and I obtained the opinion of Messrs. Sir Wm. Logan, John Young, John Redpath and John Molson, and others, which were unanimously given: That the report of the Royal Engineers did not cover the whole ground and causes of the floods, that the expense to be incurred was greatly understated, and that the works contemplated were not sufficient to perfect a remedy; they also agreed with me in urging the filling up to the water level all the low parts of the city subject to floods.

While the filling up of low places was going on authority was obtained from the city council to make surveys of ice jams. This was done from time to time by the city surveyor and his assistants, the maps of which show that the effect is as herein stated, and that when the ice jams extend far below the city the difference of water level between the Victoria Bridge and below Hochelaga is but trifling, thus the difficulty of draining into the river within the city limits is serious when there is a high flood, involving the necessity of going far below the city to escape the difficulty caused by water breaking up the discharging outlets. When the ice jams extend to the foot of the island of Montreal, &c., the Ottawa River ice joins that of the St. Lawrence River on the shoals below, the drainage difficulty is farther augmented.

It was my desire that the late Mr. McQueen, city surveyor, should make a thorough report of the different ice jams and floods, and his surveys taken in each winter when he was at work upon it. I gave him the use of my ice and flood notes, taken from 1837-38 onward. These I have not been able to find, therefore I have written these descriptions on floods from memory without giving the dates and measurements my memorandum contained.

It should be remembered that the city has expended a very large amount in improving the flooded district. Craig and Commissioners Street creeks are drained and filled. St. Paul Street, College Street, St. Joseph Street and all streets between it and the canal and Point St. Charles, were more or less raised from 4 to 10 feet, in some places there were 12 feet of filling; Bonaventure Street, low places were raised and tunnelled. The waterworks embankments were raised, and a series of large and expensive tunnels were constructed, some of which were made to discharge at places I could not approve, they furnish direct and speedy means of conveying river floods to the city, from below the Victoria Bridge to Point St. Charles, from the harbor to William Street to Griffintown, and from the same place through to the McGill Street tunnel to St. Paul, Craig and Bonaventure Streets.

The large amount expended on drainage and its yet imperfect state, is evidence of the absurdity of views frequently advocated in council, namely:

That before such extensive works were undertaken, a perfect system should be fully considered with the assistance of the best engineering talent obtainable, and what is done should be a part of the whole, and suitable for the future city of Montreal. It is impossible to expect a city surveyor, who has the general and ordinary street works of the city to direct and provide for, to give up the time and study necessary to accomplish within any early period, preparatory measures and calculations for the works of so extensive an undertaking as perfect protection from floods.

I do not pretend to possess engineering skill, yet my studies have been in that direction, which, with the amount of time and attention I have had occasion to give to all such matters, and more particularly to this, and the waterworks questions, with other public works of improvement in the city of Montreal, I may be excused if on so important an occasion, I offer opinions touching the various remedies for floods which have been advanced and discussed since 1841.

It is evident from the various forms taken by the ice jams that the floods are caused by ice accumulations on the shoals and islands in the river at many places. Some relief might be obtained by the removal of a part of the river obstructions which is a work that could only be undertaken by the Government and the Harbor Commissioners, which work might be made of service to the Montréal harbor and an advantage to inland as well as sea going vessels—each piece of obstruction that is removed would assist in the remedy.

The obstructions begin above the Victoria Bridge and extend to the city front, taking in the St. Lambert wharf and shoals, also the south channel at St. Helen's Island, and the north channel from St. Helen's down. The removal of any one obstruction would not perfect the remedy, inasmuch as the damage caused by floods extends from the foot of Beauharnois Canal to all the low lands, as far down at times as Sorel, when ice jams form on the islands below Sorel. Therefore there appears to exist a fair claim on the Government for assistance, such as has been given on smaller streams and less important places. Parliament should act at once.

City and Suburban Drainage.

When the city undertakes to perform works necessary to keep out river floods, extensive drainage is needed for surface water from thaws and rainfalls over a large area outside of the city; its drainage, water works and that of the city must be provided for, and in a great measure taken to discharge far below the city. Any system which does not embrace all outlying lands draining towards the city cannot be considered reliable. If the connection between city drains and the river is shut off there will be floods in the spring, caused by the drainage and thaws or rains unless provided for. Therefore it is important to make arrangements with all outside municipalities to provide for their part of the expense of drainage, or to become a part of the city. Should the city find it necessary (as I believe it will) to carry drainage through the municipality north-east of the city, the power to do so, or annexation, would be necessary.

The land draining to the city extends from beyond Monklands on the mountain along the mountain ridge to its north-east end, thence to north of Mile End, through to Petite Côte, thence along the high lands north-easterly to below Hochelaga. There will be added to this the drainage of St. Gabriel, parts of Verdun and all low lands north of the canal from the city limits, for some distance above St. Henry.

The city surveyor would have no difficulty in preparing a plan showing the limits of the territory which sends its watershed to within the city limits, and the distance below the city it should discharge.

In consequence of the insufficiency of the Craig Street and other tunnels, it would be necessary to construct others at higher levels, each commencing at the extreme western proposed extension of city limits and extending to the proposed south-eastern limit or near it; these discharge into one or more larger tunnels afford-

ing sufficient capacity and discharging at the lowest possible point on the island of Montreal, to secure a proper outlet, without hindrance from river floods or ice jams. Even if the city should not undertake pumping of water from the sewers that discharge into the harbor, the day is not far distant when tunnels at higher points in the city would be necessary.

If it is desired to adopt a system of closing those sewers and erecting pumping machinery it is very important that drainage provision should first be made for floods entering the city from the river above Victoria Bridge, as well as for heavy spring thaws and rainfalls. When ice shoves come on, about the same time in the spring, it will be very difficult to escape being flooded, either from the tunnels or drains that receive back water from the river, while they have enough to do as it is to carry off city and suburban drainage unless aided by additional drainage discharging further down the river, or that every place of discharge be supplied with powerful, well constructed and well protected pumping machinery. I esteem it important that there should be established an outlet or outlets further north-east for part of the drainage, rather than depend entirely on pumping machinery.

Apart entirely from the flood question, portions of the main tunnels that should run east and west on higher levels are extremely important from a sanitary point of view.

Much more might be written on this subject that might appear in the course of the discussion on details, that need not now be put on paper.

The conclusions of this paper may be summed up as follows:

1st. The immediate cause of floods in Montreal is the descent and accumulation of large quantities of ice on the shoals and narrow channels, islands, &c., that are situated at several places in the river from below Sorel to the Lachine Rapids.

The Government and the Harbor Commission are the only and proper authorities to perform works on the river outside of the city limits on the frontage and elsewhere.

When the ice forms a dam above the Victoria Bridge, the flood enters the city from the Lower Lachine road and drains. When it forms on shoals in the harbor, floods enter the drains at Point St. Charles, the low places there and Lower Lachine road; when it forms on the shoals and narrow channels of St. Helen, floods enter the drains of Commissioners, William, McGill, St. Joseph, Bonaventure and Craig Streets, by way of the McGill Street tunnel; when the ice obstructs the north and the south channels at St. Helen's Island, the water rises very rapidly till the ice is lifted and carried to shoals below, either to proceed down the river and lower the flood or to meet resistance from strong ice below the island that rests upon shoals opposite Hochelaga, it is again there hindered from moving and forms another dam that prolongs the flood and produces a height of water that overflows the revetment wall and extends the flood to all the lower parts of the city; when the obstruction is moved down or forms between Longue Pointe and the Boucherville Islands, or further down the river, it floods low places both sides of the river, and passes up the city tunnels that discharge below the city, obstructs all city drainage and hinders the passage away of refuse drainage, thus becomes injurious to health and offensive to even citizens living on higher levels.

These floods vary according to the weather, to storms and to the strength of the ice at and below the city, as compared to that on the upper lakes and bays.

2nd. The remedies that have been suggested are various and extensive, most of those that have appeared seem hasty conclusions, without a full consideration of the whole question and knowledge of all the difficulties,—even engineers contradict one another; nevertheless I have endeavored to consider every point of importance, that my humble efforts admitted, to arrive at conclusions, now presented for consideration by any who may feel disposed to bring a high order of skill and acquired attainments to bear upon the subject.

Recommendations.

Leave the river works to the Government and the Harbor Commissioners; obtain from the Government and the Harbor Commission assistance to rebuild the

revetment wall, elevate and strengthen it all along the harbor front, till it reaches the embankment of the Victoria Bridge.

Convert the road along the revetment wall into a boulevard, and continue it to the water-works embankment, make the whole sufficiently high and strong to keep out high floods. If the municipality of Verdun annexes to the city, the embankment might be continued from Victoria Bridge along the river front as far up the Lower Laohine road as necessary.

Construct a tunnel under the above roadway of the capacity necessary to carry drainage below the city, and erect there a pumping station to be used when required.

Fill up to a uniform level all low public streets and places that ordinary floods occasionally cover.

Annex all outside municipalities that drain and send water into the city, and that are so located as to be on the route to be adopted for extending city tunnels to a lower place of discharge.

Construct two main tunnels on higher levels than Craig Street to relieve the tunnel there, and let the Craig Street tunnel and those about it discharge into one or more larger tunnels, to be constructed far below the city, discharging into the river at a point as little as possible likely to be interrupted by back water from high floods; and build a pumping station to clear tunnels, if necessary at high floods.

It would be presumption for any other than an engineer of great experience and much knowledge of the localities to undertake the task of considering this question in all its details, without obtaining full and perfect information as to all phases of the action of the ice and waters; and it is out of the question for any person not a first class engineer, even then, to estimate and determine all questions connected with the perfect completion of works in all their details and furnish precise figures to which the cost would amount.

Canada need not import engineers fitted for the task, there is sufficient and reliable engineering talent available in Canada to estimate and direct the work without resorting to expensive experiments.

It is to be hoped that the Government, the Harbor Commission, the Corporation of Montreal, and all the adjoining municipalities, will not hesitate to join heartily in the important work of reclaiming Montreal and its neighborhood, as well as all places that suffer, and thus demonstrate the ability, the enterprise, and the power to subdue all difficulties necessary to retain for the commercial metropolis of Canada that supremacy which thus far has been so nobly earned by our people.

The whole respectfully submitted,

WILLIAM RODDEN.

PLANTAGENET SPRINGS, April, 1886.

N. B.—Since the foregoing was written, Montreal and the surrounding municipalities have suffered from one of the most destructive floods that has been experienced. The ice shoves of last winter accumulated upon the shoals fronting the city and below it. The cold snap that followed ice shoves had the effect of holding the ice in compact masses, in many places resting on the river bottom, till the thaw set in on the river and lakes above, and there swelled the floods that raised the ice while yet strong, and brought it down before the harbor ice had weakened enough to be moved away by the force of the descending strong ice and flood. The resisting power of the piles of ice in and below the harbor caused the descending ice to fill the channels and back up the waters, till the flood reached a height over every other flood but one, in the memory of the writer, and caused much more damage than any preceding flood. Some of this damage need not have occurred had there been a full appreciation of the signs of danger to be found in the strength and quantity of ice near Montreal, when compared with the strength of ice above and the probability of its early downward movement being caused by the early thaw in the west.

WILLIAM RODDEN.

ON THE PACKING OF THE ICE IN THE RIVER ST. LAWRENCE.

A paper by the late Sir William E. Logan, read before the Geological Society of London, and published in its proceedings Vol. III, page 768, June, 1842. Reprinted, with the author's permission in the Canadian Naturalist, Vol. III, page 115, anno, 1853.

The Island of Montreal stands at the confluence of the rivers Ottawa and St. Lawrence, and is the largest of several islands splitting up these mighty streams, which cannot be said to be thoroughly mingled until they have descended some miles below the whole cluster.

The rivers first come in contact in a considerable sheet of water called Lake St. Louis, which separates the upper part of the Island of Montreal from the southern main. But, though the streams here touch, they do not mingle. The waters of the St. Lawrence which are beautifully clear and transparent, keep along the southern shore, while those of the Ottawa, of a darker aspect, though by no means turbid, wash the banks of the island; and the contrast of color they present strongly marks their line of contact for many miles.

Lake St. Louis is at the widest part about six miles broad, with a length of twelve miles. It gradually narrows toward the lower end, and the river as it issues from it, becoming compressed into the space of half a mile, rushes with great violence down the rapids of Lachine, and although the stream is known to be upwards of eight feet deep, it is thrown into huge surges of nearly as many feet high as it passes over its rocky bottom, which at this spot is composed of layers of trap extending into floors that lie in successive steps.

At the termination of this cascade the river expands to a breadth of four miles, and flows gently on, until it again becomes cramped up by islands and shallows opposite the city of Montreal. From Windmill Point and Point St. Charles, above the town, several ledges of rock, composed of trap lying in floors which in seasons of low water are not much below the surface, shoot out into the stream about 1,000 yards; and similar layers pointing to these come out from Longueuil on the opposite shore. In the narrow channel between them, the water, rushing with much force, produce the Sault Normand, and cooped up a little lower down by the Island of St. Helen and several projecting patches of trap, it forms St. Mary's current.

The interval between St. Helen and the South Shore is greater than that between it and Montreal; but the former is so floored and crossed by hard trap rocks, that the St. Lawrence has as yet produced but little effect in wearing them down, while in the latter it has cut out a channel between thirty and forty feet deep, through which the chief part of its waters rush with a velocity equal to six miles per hour. It is computed that by this channel alone upwards of a million of tons flow past the town every minute.

Between this point and Lake St. Peter, about fifty miles down, the river has an average breadth of two miles, and proceeding in its course with a moderate current, accelerated or retarded a little according to the presence or absence of shoals, it enters the lake by a multitude of channels cut through its delta, and forming a group of low flat alluvial islands.

The frosts commence about the end of November, and a margin of ice of some strength soon forms along the shores of the river and around every island and projecting rock in it; and wherever there is still water, it is immediately covered.

The wind acting on this glacial fringe, breaks off portions in various parts, and these proceeding down the stream constitute a moving border on the outside of the stationary one, which, as the intensity of the cold increases, is continually augmented by the adherence of the ice-sheets which have been coasting along it; and as the stationary border thus robs the moving one, this still further outflanks the other, until in some part the margins from the opposite shores nearly meeting, the floating ice becomes jammed up between them, and a night of severe frost forms a bridge across the river. The first ice bridge below Montreal is usually formed at the

entrance of the river into Lake St. Peter, where the many channels into which the stream is split up greatly assist the process.

As soon as this winter barrier is thrown across (generally toward Christmas) it of course rapidly increases by stopping the progress of the downward floating ice, which has by this time assumed a character of considerable grandeur, nearly the whole surface of the stream being covered with it; and the quantity is so great that to account for the supply, many, unassisted with the supposition of a marginal origin, have recourse to the hypothesis that a very large portion is formed on and derived from the bottom of the river, where rapid currents exist.

But, whatever its origin, it now moves in solid and extensive fields, and whenever it meets with an obstacle in its course, the momentum of the mass breaks up the striking part into huge fragments that pile over one another; or if the obstacle be stationary the fragments are driven under it and there closely packed. Beneath the constantly widening ice barrier mentioned an enormous quantity is thus driven, particularly when the barrier gains any position where the current is stronger than usual.

The augmented force with which the masses there move pushes and packs so much below that the space left for the river to flow in is greatly diminished, and the consequence is a perceptible rise of the waters above, which, indeed, from the very first taking of the bridge gradually and slowly increase for a considerable way up.

There is no place on the St. Lawrence where all the phenomena of the taking, packing and shoving of the ice are so grandly displayed as in the neighborhood of Montreal. The violence of the currents is here so great, and the river in some places expands to such a width, that whether we consider the prodigious extent of the masses moved or the force with which they are propelled, nothing can afford a more majestic spectacle or impress the mind more thoroughly with a sense of irresistible power.

Standing for hours together upon the bank overlooking St. Mary's current I have seen league after league of ice crushed and broken against the barrier lower down, and there submerged and crammed beneath, and when we reflect that an operation similar to this occurs in many places from Lake St. Peter upwards, it will not surprise us that the river should gradually swell.

By the time the ice has become stationary at the foot of St. Mary's current the waters of the St. Lawrence have usually risen several feet in the harbor of Montreal, and as the space through which this current flows affords a deep and narrow passage for nearly the whole body of the river, it may well be imagined that when the packing here begins the inundation rapidly increases.

The confined nature of this part of the channel affords a more ready resistance to the progress of the ice, while the violence of the current brings such an abundant supply, and packs it with so much force, that the river dammed up by the barrier, which in many places reaches to the bottom, attains in the harbor a height usually twenty and sometimes twenty-six feet above its summer level; and it is not uncommon between this point and the foot of the current within the distance of a mile to see a difference in elevation of several feet, which undergoes many rapid changes, the waters ebbing or flowing according to the amount of impediment they meet with in their progress from submerged ice.

It is at this period that the grandest movements of the ice occur. From the effect of packing and piling and the accumulation of the snows of the season, the saturation of these with water, and the freezing of the whole into a solid body, it attains the thickness of ten to twenty feet, and even more; and after it has become fixed so far as the eye can reach, a sudden rise in the water, occasioned no doubt in the manner mentioned, lifting up a wide expanse of the whole covering of the river so high as to free and start it from the many points of rest and resistance offered by the bottom, where it had been packed deep enough to touch it, the vast mass is set in motion by the whole hydraulic power of this gigantic stream. Proceeding onward with a truly terrific majesty, it piles up over every obstacle it encounters, and when spread into a narrow part of the channel, the lateral pressure it there exerts drives

the bordage up the banks where it sometimes accumulates to the height of forty or fifty feet. In front of the town of Montreal there has lately been built a magnificent revetment wall of cut limestone to the height of twenty-three feet above the summer level of the river. This wall is now a great protection against the effects of the ice. Broken by it, the ice piles on the street or terrace surmounting it, and there stops; but before the wall was built, the sloping bank guided the moving mass up to gardens and houses in a very dangerous manner, and many accidents used to occur.

It has been known to pile up against the side of a house more than 200 feet from the margin of the river, and there break in at the window of the second floor. I have seen it mount a terraced garden twenty feet above the bank, and crossing the garden enter one of the principal streets of the town. A few years before the erection of the revetment wall, a friend of mine, tempted by the commercial advantages of the position, ventured to build a large cut stone warehouse, 180 feet long and four or five storeys high, closer than usual upon the margin of the harbor. The cellar floor was not more than eight feet above the summer level of the river. At the taking of the ice, the usual rise of the water of course inundated the lower storey, and the whole building becoming surrounded by a frozen sheet, a general expectation was entertained that it would be prostrated by the first movement.

But the proprietor had taken a very simple and effectual precaution to prevent this. Just before the rise of the waters, he securely laid against three sides of the building at an angle of less than 45° , a number of stout oak logs a few feet asunder. When the movement came the sheet of ice was broken and pushed up the wooden inclined plane thus formed, at the top of which meeting the wall of the building, it was deflected into a vertical position, and fell back.

In this manner such an enormous rampart of ice was in a few minutes placed in front of the warehouse as completely shielded it from all possible danger. In some years the ice has piled up nearly as high as the roof of this building. Another gentleman, encouraged by the security which this warehouse apparently enjoyed, erected one of great strength and equal magnitude on the next water lot, but he omitted to protect it in the same way. The result might have been anticipated. A movement of the ice occurring, the great sheet struck the walls at right angles, and pushed over the building as if it had been a house of cards. Both positions are now secured by the revetment wall.

Several movements of the grand order just mentioned occur before the final setting of the ice, and such is immediately preceded by a sudden rise of the river. Sometimes several days and occasionally but a few hours will intervene between them; and it is fortunate that there is a criterion by which the inhabitants are made aware when the ice may be considered at rest for the season, and when it has therefore become safe for them to cut their winter roads across its rough and pinnaled surface. This is never the case until a longitudinal opening of considerable extent appears in some parts of St. Mary's current. It has embarrassed many to give a satisfactory reason why this rule, derived from the experience of the peasantry, should be depended on. But the explanation is extremely simple. The opening is merely an indication that a free sub-glacial passage has been made for itself by the water, through the combined influence of erosion and temperature, the effect of which, where the current is strongest, has been to wear through to the surface. The formation of this passage shows the cessation of a supply of submerged ice, and a consequent security against any further rise of the river to loosen its covering for any further movement. The opening is thus a true mark of safety. It lasts the whole winter, never freezing over even when the temperature of the air reaches 30° below zero of Fahrenheit, and from its first appearance the waters of the inundation gradually subside, escaping through the channel of which it is the index.

The waters seldom, if ever, however, fall so low as to attain their summer level but the subsidence is sufficiently great to demonstrate clearly the prodigious extent to which the ice has been packed, and to show that over great occasional areas it has reached to the very bottom of the river. For it will immediately occur to everyone that when the mass rests on the bottom its height will not be diminished by the

subsidence of the water, and that as this proceeds the ice, according to the thickness which it has in various parts attained, will present various elevations after it has found a resting place beneath, until just so much is left supported by the stream as is sufficient to permit its free escape.

When the subsidence has attained its maximum, the trough of the St. Lawrence therefore exhibits a glacial landscape, undulating into hills and valleys that run in various directions, and while some of the principal mounds stand upon a base of 500 yards in length, by 100 or 200 yards in breadth, they present a height of 10 to 15 feet above the level of those parts still supported on the water.

On the banks of the St. Lawrence, in the neighborhood of Montreal, there is an immense collection of boulders, chiefly from rocks of igneous origin, and among them syenite greatly abounds. They are of all sizes, but many are very large, and multitudes must be tons in weight. From their appearance above the surface in shallow parts of the river, it is very probable the bed of it teems with them also; and it is remarked by the inhabitants that the positions of these boulders, both in the river and on the banks, frequently appear changed after the removal of the ice in the spring.

I spent several days in the autumn of last year examining the boulders along shore, all the way from Montreal to Lachine, a distance of 9 miles; and on again looking at them in the spring I missed some which had particularly attracted my attention, but as I had not mapped their positions I may inadvertently have passed them over. But when we consider the manner in which the ice packs and subsequently moves, it cannot fail to appear a very probable agent in transporting these blocks.

Closely jammed together down to the very bottom of the river over such extensive areas as have been mentioned, and there solidified by severe frosts, around the projecting materials that present themselves to its grasp, the ice must seize a multitude of the loose boulders below; and not only will these be carried away, occasionally to very considerable distances, when it breaks up in the spring, but firmly set in their glacial matrix, they will, when, in the course of the movements that occur, such masses as hold them are forced over shallow places act as gravers to register in parallel grooves on the face of such rocks as they encounter a memento of their progress as they pass along.

The boulders in the middle of the river may at once be occasionally carried to considerable distances; but it can scarcely be so with such as are stationed at or near the borders. For though these may become packed and embedded in marginal ice, and by the force of a general movement or shove as it is termed by the inhabitants, be driven obliquely up the bank, as soon as this ceases they will there be left; and as these general movements occur only three or four times during a season, and are never of long continuance, and even where the marginal ice is driven up the bank the friction it suffers soon causes succeeding portions to pile over one another, it is evident the boulders would not be carried by it to any very great distance.

When a break up occurs in the spring, it is the great body of ice in the middle of the river that is carried away, which separating from the grounded portion on the margin, leaves this to be melted down by the increasing temperature of the season. The movements of succeeding winters may push marginal boulders farther and farther on, but they must at the same time have a tendency to carry all within a certain range gradually nearer to the bank, and at last place them in a position at the very limit of their influence. And it is certainly the case that in the neighborhood of Montreal there are in many places along the borders of the river collections of boulders sufficiently great to induce the supposition that their presence may be accounted for in this manner.

It is not, however, only on the immediate banks of the St. Lawrence that boulders abound. They are more or less spread over the whole island of Montreal, and over the plains on the opposite side of the river.

I do not pretend to have ascertained their distribution with the precision necessary to permit the expression of an opinion as to the causes which placed them, but

I may state that they appeared to me more abundant in the upper part of the island than in the lower, and that proceeding down the valley of the St. Lawrence they ceased altogether not many miles below the island in question: and it may be further remarked that they did not seem of less weight at the limit of their range than elsewhere.

(Translation.)

Capt. in CHARLES LEGER, of Lachine, expressed his views as to the mitigation of the floods, as follows:—

In order to understand well what I am going to say to you, you must listen well to me. I have navigated the St. Lawrence and the Ottawa during some thirty years, and I know these rivers thoroughly well. When the wind is south the ice breaks up from about three miles above Isle Dorval to below Lachine. When the wind is north or north-east the ice all breaks up in the large bay of Pointe Claire.

On the 3rd, 4th, 5th, and 6th of January, 1886, the ice was broken up below Isle Dorval, the wind veered round north-east on the evening of the 8th of January, a very strong high wind and then very cold; on the 9th there was a heavy snow storm and then the same wind, and the ice broke up to the large bay of Pointe Claire, and came down on the 10th and the 11th, which was what caused the floods at Montreal.

On the 15th, 16th and 17th January, 1886, the ice coming from Pointe Claire passed Lachine, and caused the water to rise here 15 inches. On the 22nd, 23rd, 24th, 25th, 26th and 27th, the frazil coming from Lake St. Louis below the ice, came down the river in front of Lachine in quantity, so much so that the canoe-men had difficulty in getting the mail across from one side of the river to the other, the water instead of rising fell a good deal.

I would suggest that ten (10) piers of fifty feet square each and ten feet high be constructed from Isle Dorval to Isle St. Nicolas, a distance of three thousand (3,000) feet in width, under my direction. I would place the piers and the booms below the foot of the shoals there, where there are only two feet of water at low-water, so as to stop the small ice of the autumn until the ice takes of itself, until all the other ice takes at the same time out to the middle of Isle Dorval.

I would leave free the channel for steamboats, rafts, barges and boats, which cannot pass elsewhere than in that channel, which is about 130 feet wide and not more. I would block that channel with a boom so as to stop the small autumn ice.

From the scientific point of view, as to the damages which might be claimed in consequence of the adoption of the plan which I submit, I can say in a positive manner that the water cannot rise or reach more than three feet above the regular level of the river so well for the proprietors as for navigation.

I am going to try to make you understand that my plan cannot retard the opening of navigation. Last year the Lake St. Louis ice came down on the 22nd and 23rd April, and that of Lake St. Francis came down only on the 1st May, 1885, and it is like that every year, and navigation is open only on the 17th of the same month, and navigation opens only when the lights of the lakes are put in place.

The whole undertaking can be carried out for a sum of \$36,000.

his
CHARLES X LEGER.
mark

Witnesses—N. THIBAUT, E. CHRISTIN.

P. S.—The construction of these piers and booms cannot in any way hinder the free flow of the waters of the Chateauguay River at its mouth. If at any time you desire fuller information I am ready to give you all the information that you want, whether about Vaudreuil or Isle Perrault.

(Translation.)

MONTREAL, 27th January, 1886.

SIR,— Not having had the advantage the other day of explaining myself in English as I would have liked to have done, I take the liberty to-day of writing you these few words to lay before you humbly my opinion upon the causes of the floods from which you have suffered for a number of years, which may put you in a position to study the question more easily. Now this is my opinion: In the first place you know that for some years past they have been dredging the bottom of the river, and that the earth which is moved finds a resting place somewhere. I, as an old hunter, go to these islands several times every year, and I have remarked that at the entrance of each channel there is a shoal which obstructs the passage of the water. Besides that, there is also the ice of the Longueuil eddy which takes and breaks two or three times before the ice bridge finally takes, and this ice, which is seven or eight inches in thickness, when breaking goes off and grounds in large banks at the entrance of each channel or on other shoals, which, according to me, are formed (the shoals) by the earth which is thrown in near the islets below Longueuil, then each channel being blocked and the shoals being also heaped up with ice, according to my opinion these are the causes of the floods, and it is these mountains of ice which stop the flow of the water, and then the rising water causes all these disasters. I conclude, Mr. Chairman, by submitting my opinion to your consideration, as perhaps it will assist you somewhat.

I am, sir, your obedient servant,
JOSEPH JANNARD.

The Chairman of the Floods Committee.

(Translation.)

THE CAUSE OF THE FLOODS.

I consider that the rise of the water is produced by the accumulation of the ice. In autumn fields of ice from Lakes St. Francis and St. Louis come down the river, for it must be remarked that the ice takes more quickly below than above Montreal, and when these ice floes arrive in the neighborhood of Verchères they meet the solid ice, and being forced on by the water they accumulate to the degree of obstructing the passage of the water, which explains the autumn floods. The floods cease as soon as the ice has taken on Lakes St. Francis and St. Louis.

In the spring the flood is produced by the same causes as in the autumn; the ice from below (? above) comes down the river in fields, which are sometimes from 3 to 4 miles long and even more, and when it meets the solid ice, forced on by the water, it accumulates and blocks the passage of the water which is already obstructed by the autumn ice; hence the floods, the water no longer finding a sufficient passage, rises and soon overflows the banks and causes the damage and havoc which you know.

Means of preventing the Floods.

Place above the rapids, that is to say at the foot of the lakes, piers from one shore to the other, which should be placed in such a way as not to impede navigation. These piers at the foot of Lakes St. Francis and St. Louis would have the effect of hastening the taking of the ice at these places and would then retain the ice floes coming down, and delay by so much the causes of the autumn floods, and in the spring it would retard the descent of the ice from above and would give time for the ice from below to descend before the ice from above arrived. It is to be understood that if piers were placed in Lake St. Louis only, the same results would probably be had, but the consequence would be the inundation of Beauharnois and neighboring places; but by thus putting piers at the foot of Lake St. Francis there is no fear of floods; and it will be understood that the amount of ice which will come down will be considerably less.

Moreover, make a canal at St. Lambert 300 feet wide going as far as Longueuil or lower down, giving it all the depth possible while keeping a strong enough fall, and in such a way that the water being let into the canal would exercise a pressure on the ice; and at the head of this canal make a basin of 300 by 600 feet; put twelve gates of 10 feet each in it to communicate with the canal; this basin should be so constructed that there should be no current at this place, it should be dead water in order that the ice may take there earlier than elsewhere, and then that the ice coming down should not enter this basin. In the spring when the time of the breaking up of the ice comes, these gates would be opened, and the water descending this canal as far as Longueuil would go to force the ice on and hasten its departure before the ice from above came down.

The whole humbly submitted.

CYRIAC LABELLE.

363 Workman Street, St. Canégonde.

To His Worship the Mayor and the Aldermen of the City of Montreal.

The memorial of the Council of the Montreal Board of Trade respectfully sheweth:

That the Council of the Montreal Board of Trade having carefully considered the matter of the periodical inundations of the lower districts of the city, desires earnestly to recommend that the civic authorities do, without loss of time, make a vigorous effort to establish the causes of, and find a remedy for, these recurring calamities.

That the importance of the subject is too obvious to render argument necessary, and it is needful only to point out that, as a matter of fact, the river never rises above a certain level without causing a considerable money loss from the destruction or damage to merchandize, while this loss, great as it is, is of less moment than the misery caused to large numbers of people who reside in the district so flooded.

That in addition to these obvious evils, the first effect of the rise of the river being to reverse the flow in all the drains and sewers, all the cellars and streets in these districts are saturated with sewage, and therefore that in parts of the city where no outward effects of the flood are apparent, sewage gas must, as a matter of course, be forced into the dwellings with consequences to the public health which cannot be over-stated.

That the Council of the Board of Trade, while desirous of avoiding all intrusion on the province of the civic authorities, conceives it to be necessary to make a specific statement of the course it is prepared to recommend as follows:—

The enquiry now being conducted by a special committee ought to be continued, the fullest powers be given to such committee, and a liberal appropriation of money made so that the best engineering and professional talent may be engaged to make the necessary surveys.

It should be the duty of those engineers to report fully on the causes of these floods, and to present a specific plan or plans for their prevention, with estimates of outlay.

The date at which such report is to be made should be now fixed, though it might be hereafter extended if requisite.

It is obviously necessary that no time should be lost, as the river in its winter condition can now be examined and surveyed, and, in addition, it is hoped that some stops may at once be found practicable to prevent, or at least to mitigate, the effects of the spring flood which many consider probable.

That the Council of the Board of Trade believes that the civic authorities will carry with them the approval of the mercantile and manufacturing community, and of the citizens generally, in dealing with this question in a vigorous and liberal spirit.

That it having transpired that the representative of the Board of Trade on the Inundation Committee is absent from the city, the council have this day nominated

R. Paton McLea, Esq., in his place, and desires further to say that its members are prepared to aid the proposed enquiry in every way in their power.

The whole respectfully submitted.

GEORGE A. DRUMMOND, *President.*
WILLIAM J. PATTERSON, *Secretary.*

Signed on behalf of the Council of the Montreal Board of Trade.

MONTREAL, 18th January, 1886.

METEOROLOGICAL OBSERVATIONS BY CAPTAIN CHARLES LEGER.

Observations on the changes of the weather, wind and level of the water as noted by Charles Leger at Lachine since the 16th of December, 1884, viz.:

Dec. 16th.—All the rivers were frozen in the morning, the same night very cold.

Dec. 17th, 18th, 19th and 20th very cold, with north-east wind and snow.

Dec. 21st.—All the rivers were frozen over and people were crossing the same on foot excepting within three miles of the town of Lachine (to Ile Dorval) which is always open.

On the same day (the 21st) the wind changed to south-west and blew a gale all day and the ice on Lake St. Louis did not budge; the weather kept cold until the 27th; from the 28th until 13th January the weather has been very mild, with a great deal of rain about every other day with winds from the east and south the greatest part of the time, which caused the ice along the Lachine shore up to the Island Dorval to break close up to the beach, the frazil ice floated to the surface and moved down the river with the broken ice which caused the water to rise some in Montreal. If the piers were built at Lachine the river would all freeze over from the piers to Ile Dorval and would thus prevent the making of frazil ice and would also keep the ice there, instead of drifting down the river to Montreal and cause a jam and rise of water there.

Every year the ice takes by a cold north-east wind, from Beauharnois to Lachine with the exception of the three miles above mentioned.

Before the year 1875, the four gates of the Lachine lock used to remain open from about the 15th of June till the 15th September, with only about 6 inches of fall between Beauharnois and Cote St. Paul locks.

Since the building of the new canal dam the water at the head of the pier is one foot higher than it was before. From what information I can gather from the inhabitants should the piers cause the water to rise during the winter season it would cause no inundation, even 4 feet, in the vicinity of Lachine.

Respectfully submitted by

OHAS. LEGER, *Light Pier Keeper, Lachine.*

LACHINE, 14th January, 1885.

To the Inundation Committee, Montreal.

MONTREAL, 18th May, 1886.

A. A. STEVENSON, Esq., Chairman Committee on Floods:

This is as near as I can remember the name of the Committee.

A few days ago you were good enough to say you were willing to read a letter of mine in reference to our annual floods, and how to prevent, or, at least, mitigate them.

In pursuance of that desire, I beg to say that I have had a map of Montreal and vicinity before me for a year, and the more I look at it, the more I feel satisfied that three things, if done, would greatly conduce to this desirable object in view:

- 1st. Moffatt's Island and the pier thence to St. Lambert shore, should be removed.
- 2nd. The channel south of the St. Helen's Island should be deepened. In this I find a correspondent of the *Gazette*, Mr. Sorby, agrees in a letter he wrote some days ago.

3rd. Isle Ronde should be partly or entirely removed.

By these acts, I would expect to make a direct course for the ice on either side of St. Helen's Island, and thus relieve the pressure upon the wharves.

So much for the city itself. Now, with regard to Point St. Charles, or further up, the difficulty is not so easy to solve, because of the formation of Laprairie Bay.

When the lake ice comes down it naturally pushes towards Laprairie, where we find as it were a large mouth with closed teeth (the piers of Victoria Bridge) holding it back just at the entrance to a comparatively narrow place, thus preventing the larger mass of ice, which is collected at breaking up time, from freely passing down.

The Victoria Bridge I hold to be in a bad spot for our bi-yearly welfare. However there it is and to stay, therefore we must fight around it for success.

Before closing, I might venture a suggestion or two for what they are worth. That old pier which runs out into the river nearly parallel with Victoria Bridge, ought to be removed or built over so as to point down the river, instead of nearly across, as at present.

And finally taking a jump down to Point aux Trembles and the islands that crowd the channel on the south of Isle St. Therese, it occurs to me that the removal of some of them would make a clearer course for the moving ice, and thus greatly conduce to the end in view.

I don't indulge the idea that I have made any discoveries that are new, and fear that some of my suggestions, if deemed good, would involve too serious an outlay for our purse, but I venture to express my views to show you that I am in deep sympathy with the highly important object for which your committee is organized.

I remain, sir, your obedient servant,

R. TURNBULL.

MONTREAL, 29th May, 1841.

SIR,—I have the honor to forward herewith a report, with plans and estimate of the probable expense of relieving St. Ann's suburbs of this city, as far as the levels permit, from the periodical inundation.

We have as closely as possible adhered to the instructions of His Excellency, and although the members of the commission, as appointed by His Excellency the Governor General, have not been able to meet together lately, yet as the outlines of the plan were agreed on and put in writing at their last meeting, and as from the first there was no difference of opinion as to the principles on which the plan of relief should be founded; we trust that His Excellency will be convinced that the best endeavors of all the members have been used to further the end in view.

I have the honor to be, sir, your most obedient humble servant,

P. COLE, Major Royal Engineers.

T. W. O. MURDOCK, Esq., Civil Secretary, &c., &c.

REPORT ON THE CAUSES OF THE PERIODICAL INUNDATION OF PART OF THE CITY OF MONTREAL CALLED GRIFFINTOWN OR ST. ANN'S SUBURBS, ON THE POSSIBILITY OF REMOVING THOSE CAUSES OR OF OBTAINING THEIR EFFECTS.

MONTREAL, 29th May, 1841.

In pursuance of the commands of His Excellency the Governor General as conveyed in the Civil Secretary's letter of the 15th January last, relative to the periodical inundations in the St. Ann's suburbs of this city, the commission appointed by His Excellency have the honor to submit the result of their enquiries and examinations, with plans, sections and estimates founded thereon of the probable expense of protecting the city from this calamity.

The subject naturally divides itself into several principal sections.

Division of the Subject.

1. The rise of water in Montreal harbor at the end of December, or beginning of January of each year, and on the breaking up of the ice in the spring.

The natural and artificial causes leading towards this result, and the consequent flooding of Griffintown.

The possibility of removing those causes or of obviating their effects.

Rise of St. Pierre River.

2. The rise of water in St. Pierre River and its effects on the inundation of the city and neighborhood with the means of preventing the evil.

Sewers and Drains.

3. The sewers, drains and their course by which the backwater of the St. Lawrence is admitted into the city before the overflow of the banks and upper quays.

Streams within the City.

4. The small streams which usually fall into the St. Lawrence within the precincts of the city, and the means of guarding against their overflow when the usual course is stopped during the inundation.

Rise in Harbor.

First. The rise of water in the harbor is obviously caused by the accumulations of ice from the rapids above, which, being stopped by the field ice below, is forced under it from the pressure above until it grounds on the shoals in and below the harbor, and being confined by the narrow channels on each side of the island of St. Helen, forms a succession of dams as far as the head of the island and the new market, from whence the inundation was on a level this winter as far as the canal; and from the information we have obtained it appears that the deviation in other years is not material.

The great body of ice in the centre of the river, when arrested in its course, shoves not only downwards but sideways towards the shores, and even backwards when out of the current, as below Windmill Point.

Ice Dams.

It then grounds, shoals and forms accumulations which, in some instances, have done damage to the houses along the quays.

The accumulations on the shoals and wharves at and above the new market being nearly parallel to the shore, do not, in our opinion, materially affect the rise of water in the river.

The communications from intelligent and observing residents who have favored us by their written or personal communications, show that the accumulations vary in extent and situation. That the relative height of water in different years corresponds with the alternations of frost and thaw before the ice becomes fixed, and that, when the frost is very steady at this period, a comparatively small rise of water may be expected, probably from the small quantity of floating ice which comes down the river.

Causes of unequal rise of Water in different Years.

It is also generally observed that when the ice passes down the east channel without choking or "shoving" that there is no excessive rise of water in the harbor, and also that if this channel be choked, as well as the western one, that the greatest rise is to be apprehended, as was the case this winter, the "air hole" or vent being below St. Helen's.

Effect of the Wharves on the Inundation.

These facts, connected with the parallel situation of the accumulations to the shore and the uniform level of the inundation above the new market, apparently prove that the wharves have no effect on the inundation. The proportion to the breadth of the river is very trifling.

Rise in Former Years.

This view is corroborated by several intelligent correspondents, who vouch from personal observation that the water has risen to a greater height before these improvements were made, and, in particular, about 50 years ago, when the water covered the whole of the southern part of St. Paul Street. Several years after this, the lower floors of the Grey Nunnery were inundated to a great depth. In the winter of 1809-10 the water rose high enough to float timber over Grey Nun Street.

In later years the greatest rise was that of 1837-38, when the water rose about one foot higher than the present year. That in 1839-40, although higher than usual, was two feet lower than that of this year.

Duration of Flood.

The duration of the highest winter flood varies. It generally does not exceed two days, as was the case this year, and the preceding, but in 1837-38, which was a very mild winter, the flood was very high, though perhaps not at its highest, during 14 days. Some relief may however be expected in less than 24 hours. The city is always more or less affected by it, in the cellars for several weeks.

Height of Flood above Lowest Water.

The greatest flood is about 20 feet above summer level in the harbor, and about 12 feet difference at St. Mary's rapid between two periods at that place.

Spring Flood.

The spring flood is lower and of less duration as the ice is then unequal to support a great head of water, but from the great body of floating ice more damage has been occasioned by the latter to the houses bordering the quays at this season than by the water.

The most remarkable effect of ice was in 1792 or '93, and in 1832 the water rose to the height of the present quay wall.

The temperature has also an effect on the spring flood, and southerly winds by detaching large portions of ice, increase the accumulations or the flood by the accompanying rain.

If the river is open at the current St. Mary, the rise of water is not to be dreaded in the spring.

From the foregoing facts and the levels taken for the commissioners, and from the coincidence of the accumulations with the narrows and shoals at and below the head of the island and the new market, we are of opinion that the obstructions affecting the inundation commence at those points, and continue downwards on both sides of the island until the river opens below it.

As before stated, there is no very high flood if the channel is open on either side of St. Helen's, which appears to prove that there is always a passage below sufficient to relieve the town.

St. Pierre River.

Secondly.—Dams of ice similar to those before mentioned are formed above the harbor, and in the channel inside of Nun's Island, which raise the water above them and back it up to the St. Pierre River until it overflows its banks, when it flows in a rapid stream downwards on the east side of the canal, and through the culvert at St. Gabriel's farm to the west side. This rise is simultaneous with that of the back water in the harbor, and meets the latter flowing southwards about the St. Gabriel's farm. Its level is about two feet above the harbor backwater, and has therefore much increased the mischief caused by the inundation. It has flowed over the canal bank in several years, and in 1837-8 to a depth of 4½ inches, and probably caused the very great flood of that year in Griffintown.

The backwater did not, in the present year, flow up the St. Pierre, beyond the culvert under the level near Mr. Gregory's. Should it do so in other years, it would

be diverted on that side from the city by a ridge running from Mr. Gregory's westwards across the upper Lachine road to the Côte. This is the dividing ridge between the water of the Holwell Creek and that of the rivulet, flowing through the Tanneries to St. Pierre.

It has been proposed to embank the St. Pierre, to prevent its overflowing on the east side of canal, but this work, by preventing the relief afforded by the overflow, might back up the water to a greater height along the banks of the St. Lawrence above the St. Pierre, and up the valley of the latter.

As the farms on the east of canal are not injured by the inundation, and do not come within our instructions, we avoid tampering with the natural course of the water.

Drains and Sewers, &c.

Thirdly. The backwater rises in the cellars of the houses within its sphere, nearly as fast as in the harbor, through the St. Ann's Creek and other drains, and also by quicksands or gravel below the level of the quay wall. The remedies we shall afterwards submit.

Quicksands.

The influence of the quicksand is probably much less than is generally supposed. If it cannot be cut off, it will at least require small means to carry it off.

Streams within the City,

Fourthly. The streams falling into the St. Lawrence, within the precincts of the city, contribute to the inundation, and the mode of remedy requires consideration.

Holwell Creek.

The Holwell Creek is merely the drain of a marsh, on the west of Upper Lachine road, as far as the ridge before mentioned on the city side of the Tanneries. It is joined near the brewery of Messrs Dow & Dow by an offset from the St. Pierre, passing through the St. Gabriel culvert.

The latter stream can be confined to the east side of canal during an inundation. The Holwell Creek discharges at Point à Callière.

Mountain Streams.

There is another stream which descends from the Côte à Barron and crosses Bloury Street near the upper end. On arriving at a swamp at the head of St. Lawrence suburb, it passes by a water course into the Craig Street tunnel, which meets the Holwell creek before its discharge at Point à Callière. This stream will be hereafter adverted to.

Remedial Plans Proposed by Individuals.

Several plans have been proposed by individuals for prevention of the rise of water in the harbor.

Excavation in the bed of the River.

The most obvious remedy is to deepen the shoals in the west channel, and to lower the small island at the foot of St. Helens to about three feet below summer level. The expense attending this plan would be very great, the effect uncertain, as it would afford very little additional relief to the channel which is 37 feet deep at low water. The effect anticipated is that it would afford scope for the escape of the ice below without forming dams.

In the summer it would have the injurious effect of lowering the water in the harbor, but, on the other hand, it would diminish the rapid of St. Mary by lowering the head, and allowing the water to spread.

Another objection to this plan is that it would require several seasons to complete it. Although it is not recommended by the commissioners for the present time and

purpose it may deserve attention at a future time, as an auxiliary means of relief, keeping always in view the effect it would have on the harbor. The shoals above the head of the current St. Mary may be removed without risk.

Proposed Mole and its Probable Effects.

It has been proposed and supported by several persons whose opinions are worthy of the greatest consideration, that a mole should be thrown out, either continuous or in detached piers, from Windmill Point on the shoals towards St. Helen's or from a point higher up the river.

Two effects are anticipated by the movers of this plan. First, that by creating dead water above it, the ice would take sooner and arrest the floating ice at a higher level and thus prevent the formation of ice dams below the harbor. Secondly, that if the mole were formed in piers, it would break the ice in small pieces, which it is expected would not form into accumulations.

The first expectation is, however, problematical, and the second superfluous, because the greater part of the ice is broken small by the rapids, particularly that which comes down immediately before the ice is fixed, and which is equally arrested by the ice below.

It was at first overlooked that the mole, if continuous would occupy about one-third of the breadth of the river, and then the water thus backed up would very much increase the rapidity of the steamboat channel in the summer, and the only bateau channel would be blocked up.

At the commencement of the winter, the ice would be arrested, either in fields or masses, above the mole and would flood lands above the rapids which are now exempt. The water which in some seasons has flowed over the canal a few inches in depth would then be precipitated over in a torrent unless the banks were raised to a height which we cannot estimate, and would create evils far more fearful than those it is proposed to avoid.

Effects of Proposed Mole.

If, instead of a continuous mole, piers were placed at intervals, the evils to be dreaded would certainly occur in proportion to the shortness of the intervals, but it is not so certain that the good effects anticipated would actually ensue.

The Commission do not therefore propose any work of this kind, but it may be a matter of future consideration as an auxiliary plan, whether a few piers may not be placed at a time, to ascertain the effect produced, and allowing several winters to elapse before further additions were made, to give a full trial of the effect.

We feel ourselves called on to dwell on the necessity of the greatest caution in attempting to cope with, or even to direct so powerful an agent.

The conflicting opinions which have been brought forward with respect to the remedy for this evil show that the subject is involved in considerable difficulty. It is indeed of a more than usually complicated nature.

COTE DES NEIGES, MONTREAL, 25th January, 1886.

To the Chairman of the Inundation Committee:

SIR,—I have the honor to forward you a printed copy of my letter, sent to the *Montreal Herald* on Friday last. Should you desire the plans and estimated cost of improvements, there described, I shall be pleased to prepare same for your perusal. The cost would be only very trifling.

Yours truly,

F. G. GILMAN.

HOW TO STOP THE INUNDATIONS.

To the Editor of the *Herald*:

SIR,—On the 13th of April I wrote to the newspapers in reference to these floods, pointing out the means employed near Penzance, in Cornwall, England, to

prevent the sea overflowing some 500 acres of land that is 8 feet below high water mark. I have myself seen storm waves run 20 feet high up the dyke without any water coming up the trapped culvert.

I have since studied this matter and find that the floods are caused by an ice bridge first taken below the city when the water is low and comparatively still. Then when a thaw in the west causes a vastly increased volume of water to come down the St. Lawrence, the softer weather, coupled with the accelerated flow derived from falling down the rapids, breaks up the thin ice near Victoria Bridge. This increased volume of water cannot escape under the ice bridge previously formed below the city, as it is firmly frozen at the lower levels, until it has lifted the whole surface, which it does gradually beginning at the upper end, the floating ice passing under same and gradually raising the whole sheet. This, in my opinion, would account for a spring flood.

A winter flood is from a combination of causes. The ice that has, owing to a thaw, passed under and commenced to raise the upper end of the bridge becomes frozen, making an effectual trap to catch and retain all frasil that floats down. By this means the barrier is increased and the water channel contracted until the flood has risen until the water is of sufficient weight to break the barrier through.

Now, sir, for the remedy. I have one that will put an end to these floods, that will make your mighty river keep its bounds for ever, and will cost the city comparatively nothing.

Some gentlemen have advised building piers above the rapids, but it is the ice from below the rapids that first causes the trouble. The impetus given the water by the fall prevents said ice forming so thick as that lower down the river. Other gentlemen advise removing certain shoals, Isle Ronde, &c.

Now, sir, if this were done what depth of water would you have in the ship's channel during summer shallows? But the gentleman who suggested removing St. Helen's Island, could perhaps devise means to replace it by the opening of navigation.

In my opinion every sewer will have to be run into the Craig Street tunnel. A separate tunnel could be made to run parallel with the river, a few feet inside the revetment wall, and by this means drain Griffintown, Point St. Charles, &c., in fact all sewers that now empty into the St. Lawrence, said tunnel to be connected at the lower end with the existing Craig Street tunnel and the whole carried to a point below the ice barrier previously referred to.

It has been proved that the waters do not rise high a few miles below the city, so if the sewers emptied there it would be impossible for flood waters to back up into any store, street, or even cellar.

Then the revetment wall would have to be rebuilt (it wants doing anyways) and raised three feet higher; the whole foot path might be raised, making a wall twelve feet wide, and so protected on the river side that people will not break their necks falling over it. The wall would need raising from Bonsecours market west, and continued up the bank of the river for about a mile above the bridge with an earthen embankment, the earth for which purpose could be brought on tramways from near the aqueduct and also partly from the dredgings of the river.

Now for the means. If instead of keeping prisoners idle, or, what is worse, employing prison labor to make cheap though comparatively useless articles, tin trinkets, &c., and thereby injuring the trade of the city, they were employed in constructing such works as the above, it would confer an immense benefit upon the honest poor who are now flooded out, and cost, as I said before, comparatively nothing.

In foreign countries work of this kind is done by prisoners. In France, I have read, the cornice road from Marseilles to Genoa, some 160 miles, built through rock the greatest part of the way, was done almost entirely by prisoners from Toulon under the first Napoleon. In England I have myself many times seen a gang of prisoners at work building the Weymouth breakwater. It is an immense structure, about five miles long, and would cost many millions of pounds, but for utilising that which is in Montreal a "latent power."

Yours truly, F. G. GILMAN.

146 ST. JAMES STREET, MONTREAL, 19th January, 1886.

SIR,—At the request of Mr. George Drummond, I beg to lay before you some points in connection with my scheme for relieving the city from floods, which was published in the *Star* last week. These points are as follows:—

Firstly.—The still water harbor mentioned as being possible after our drains had been all diverted into the Craig Street tunnel, was only referred to as an improvement which might be carried out; it forms no part of the project for avoiding the floods.

Secondly.—The extension of the Craig Street tunnel down to the Ruisseau Migeon is in any case very desirable, for during very high water the drainage has no proper outlet, but keeps floating about under the city with the water in the river, and not only generating gases which must be very injurious to the health of the city, but also depositing large quantities of solid matter in the drains.

Thirdly.—If the drainage of St. Gabriel was all brought under the canal to join the extension of Craig Street tunnel, a splendid opportunity would be afforded of flushing the tunnel with water from the canal.

Fourthly.—The extension of the Craig Street tunnel will be required at no very distant date in any case.

Fifthly.—After diverting the drains from the harbor, we should have no more complaints about the polluted water along the river front.

Sixthly.—From remarks I have heard, I would wish to explain how I propose to deal with the drainage during floods. I propose, when necessary, to shut off the connections between the main drain and the river at the Ruisseau Migeon, and either pump it over the sluices into the river through a long pipe supported by stays, or through a pipe carried along the bed of the river to some point out of the way of navigation, and protected at its extremity with a crib-work, or else let the drainage flow into a reservoir during the floods, and let it flow out when the water falls sufficiently; on these last points I have no data which would enable me to form an opinion as to which would be the best method.

Seventhly.—The cost of the scheme I propose can be definitely ascertained, and its success is certain, whereas in dealing with the river, unless St. Helen's Island be removed, which is quite out of the question, no one can tell what the success would be; under certain conditions a flood could be avoided, but under others the water is certain to rise.

Eighthly.—To raise the level of the streets would only give a small measure of relief, as the cellars and yards would still have to be filled and the houses raised—it being remembered that cellars are very necessary to store provisions in.

Ninthly.—Since writing to Mr. Drummond, I have seen the report of the Royal Engineers on the question at issue, and, taking into consideration the changes in the city, their proposal seems almost the same as mine.

Tenthly.—The scheme I propose would not only relieve the city from floods, but also give a perfect system of drainage.

Finally.—I wrote the letter published in the *Star* simply as a citizen who has an interest in the welfare of the city of Montreal.

I have not as has been estimated any "axe to grind" in the matter, as I have not yet found surveying in Montreal sufficiently profitable to be able to invest in flooded cellars in St. Paul Street, nor do I expect to derive any professional benefit from my scheme, as the works, if carried out, would be under control of the city surveyor; and, in fact, any investigation into the condition of the river would be more likely to be profitable, as Mr. Rielle might be called on to furnish a copy of the large plan which he has of the River St. Lawrence on a scale of 200 feet to the inch, and which comprises that part of the river lying between Lachine and the Boucher-ville Islands, showing the contours of the ground, the level of the water at various points, and well established bench marks along each side.

Your obedient servant,

H. IRWIN.

ALDERMAN STEVENSON, Chairman of the Inundation Committee.

146 ST. JAMES STREET, 4th February, 1886.

SIR,—Allow me to call your attention to one point in the published account of Mr. St. George's report, which, I think, requires explanation.

Mr. St. George cites the fact that the Worthington engine can only deliver 8,000,000 gallons per day, as proof of the impracticability of pumping the sewerage in time of floods.

Mr. St. George seems to have overlooked the fact that the 8,000,000 gallons are to be raised some 200 feet, whereas the sewerage at the Ruisseau Migeon outlet would only have to be lifted some 16 feet.

It follows from this that an engine of the same horse power as the Worthington could deal with 100,000,000 gallons of sewerage at the point stated above.

Besides an engine could, owing to improvements, be now bought at the same price as the Worthington, we should have an engine able to pump 125,000,000 gallons per 24 hours.

Again, the Worthington type is by no means the most suitable for low lifts. In the *Scientific American* supplement for 9th August, 1884, you will see an account of a centrifugal pump (for emptying the caissons of a floating dock), which has a capacity of some 208,800,000 gallons for 24 hours.

With regard to the water from the upper part of the city, I had no idea that it discharged into the Craig Street tunnel. I was under the impression that it was conducted along a higher level drain, and emptied into the Colborne Avenue tunnel.

In this, as in most other matters relating to the scheme I proposed, I could propose no details, as I am unable to get at the necessary data. Surely no sane engineer would propose to pump the drainage of the higher parts of the city into the river.

If Mr. St. George would inform Messrs. R. H. Buchanan & Co. of the quantity of water to be pumped per 24 hours, and the height to which it would have to be raised, I have no doubt they would give you an approximate tender on very short notice.

I do not propose to trouble you any more on this subject, as I think I have succeeded in turning the attention of the authorities from the idea of dealing with the river to the more practicable and less costly scheme of keeping the water out of the sewers and raising the banks where necessary.

This was the object I had in view in writing my letter of 12th January last.

Your obedient servant,

H. IRWIN.

ALDERMAN STEVENSON, Chairman Inundation Committee.

OVID M. GOULD, Esq., testified as follows:—

I called here to draw the attention of the Committee to the fact that the City Surveyor has been taking levels of the river, and in conversation with him he stated that he was not authorized to make a very extensive survey.

The levels which have been already taken go to show that the dam which causes the flooding of the city now seems to be located somewhere between Isle Ronde and Victoria Bridge.

I suggested to the City Surveyor that it might be possible to blow it up with dynamite as an experiment which might not be so costly after all.

I would suggest that this Committee recommend to Council that the City Surveyor be authorized to make a more extensive survey, and if, after such survey, in his opinion it should seem feasible to blow up the ice jam with dynamite, or any explosive, as an experiment, that he be instructed to make the attempt, and so ascertain if the obstructions could not be removed.

I think that the flooding of Point St. Charles was caused by the water backing up through the sewers.

OVID M. GOULD.

Ex-Alderman TANSEY appeared before the Committee and testified as follows:—

On William and Kennedy Streets, I remember that in 1847, the water rose to a certain height, and I was compelled to drive in a cart to go to school. This winter I know that the very house in which I lived in 1847, is flooded to a height never attained during the time I occupied it, on account of the raising of the streets in that locality. This shows clearly that the water rose to a higher point now than it did in those times, but the raising of the streets showed it only six inches in some places where it was three feet in those days. I am of opinion that the streets of St. Ann's Ward should be raised. It would cost a great deal to raise the level of the streets, and it would be a step in the right direction towards mitigating the frequent occurrence of the floods; scrapings from the streets of the city and stone taken from the excavation for the laying of water pipes in St. Jean Baptiste Ward could be used to do this work, and tenants could be requested to keep their cinders apart and the same could be used for that purpose.

The revetment wall is tumbling down and some repairs should be made to it;— water above McGee's bridge is twelve feet higher than the level of Point St. Charles, and we are not flooded from it, for the simple reason that the embankment is sufficiently strong and high to prevent the water from overflowing the bank. And now, for a remedy against the frequent floods at Point St. Charles. I would suggest that the present bank of the tail race on the north east side be raised at least three feet, commencing at the wheel house, thence to the river, and then extend it to Victoria Bridge and from there to Mill Street, and then place a sluice gate at the outlet of the tunnel at that point which could be regulated to close or open by the rise or fall of the water, then to place a pumping engine or a turbine wheel to pump the sewage over into the bank into the river if necessary. The same plan could be adopted for the other outlets in the city.

The Harbor Commissioners should raise the revetment wall from Black's bridge, to the Canadian Pacific Railway depot or thereabouts.

Alderman Laurent: If the streets are raised, will not the proprietors claim damages?

In answer to this question, I say that, as far as I am concerned, personally, I shall not claim damages, and I would prefer to step out on a macadamized street than to have to step into the water.

I would further recommend that the levels of the water at present be taken, and that the streets should be raised according to the present level of the water only. By doing so there could be very few houses that would require to be raised; some could be raised bodily, and more could be raised by placing an extra joist of 10 or 12 inches on the first floor.

I would recommend also legislation to protect the city against damages caused in consequence of the raising of the streets, also to exempt proprietors and others from any expense in consequence thereof.

I am of opinion that prompt action should at once be taken; I do not approve of any expense for surveys being made, as I consider that the corporation possesses sufficient engineering skill to carry out the scheme as far as the city is concerned.

D. TANSEY.

Point St. Charles.

Mr. THOMAS WEBB, of the city of Montreal, testified as follows:—

I have resided in St. Ann's Ward for over thirty years; we have had water almost during the whole of that period. There have been numbers of plans got up to prevent the rise of water in that ward, but they never succeeded so far. I took the trouble of visiting this year's flood, being well acquainted with every inch of the flooded district, and I saw that a great improvement had been made by raising the streets. When I was a boy, I lived near William, where I saw eight feet of water various times; this year I find quite dry and free of water. In the premises that I occupied, with this year's flood we would have had about 4½ feet. At present there are but 10 inches in the premises.

Our city drains into the river; therefore, the water returns by the same way it goes. Anchor ice gets in under the ice, and chokes up the channel.

If you have a survey of the river made between Montreal and Bout de l'Île, you will find that there are three different levels. There are large shoals opposite the Hudon cotton factory, and anchor ice generally settles there.

If Isle Ronde were removed, as has been suggested, Longueuil would undoubtedly greatly suffer by it.

Our first trouble commences at Bout de l'Île. If the river is low in the fall, we are sure of high water, as the river here is encumbered with small islands, and the channel is crooked. Three nights' frost causes the ice to form sufficiently strong to cross; then the drift ice commences to choke the stream; then at Longue Pointe another rise by the anchor ice at the Hudon cotton factory by the long shoals, causes the water to overflow the city. To remove the islands, Isle Ronde and St. Helen would do no good. They talk of abutments of use in the river; there were 4 or 5 built where the bridge crosses, by the advice of some engineers, to retain the ice in the Laprairie Bay. They proved to be an expense and for no purpose, so they were broken up and carried away by the ice; that proved their great service.

I would say, remove those small islands below Boucherville Island, that would give more room to form a greater passage and prevent the choke here; then if the river is high in the fall we are not in so much danger of being troubled, as the very passage is increased thereby.

THOMAS WEBB.

196 St. Antoine Street.

COTE DES NEIGES, MONTREAL, 20th January, 1886.

ALDERMAN STEVENSON.

SIR.—I understood that a meeting of the Inundation Committee would be held in the City Hall on Tuesday last at 3 p.m.

Under that impression I wrote the letter left at your house on Tuesday night, intended to have read same myself, and made certain corrections that it seemed unnecessary to write down. The most pertinent that occurs to me just now is after the words "Craig Street tunnel" I should have said: A separate tunnel could be made to run parallel with the river a few feet inside the revetment wall, and by this means drain Point St. Charles, Griffintown, &c., in fact, all sewers that now empty into the St. Lawrence—said tunnel to be connected at the lower end with the existing Craig Street tunnel, and the whole carried to a point below the ice barrier previously referred to.

Yours truly,

F. G. GILMAN.

GUARDING AGAINST FLOODS.

MONTREAL, 28th April, 1885.

To the Editor of the *Herald*:

SIR.—Surely it is possible in future to prevent the disastrous floods in the low-lying parts of this city

Near Penzance, England, there is a tract of land, some 500 acres in extent close to the sea, that is never flooded, although it is some 8 feet below high tide, a reservoir of about an acre holds all the surface water from this land; it is separated from the sea by a high bank; at low tide the water is drained off by two culverts, about 2 feet in diameter; each culvert is laid in cement and slightly sloped at the mouth; a piece of leather, strengthened on the outer side by sheet iron, is hung over said mouth of culvert forming a valve which effectually prevents any water returning, no matter how high and rough the sea. These drains are very simple, would last many years, and ought not to cost more than one flood does.

Yours truly,

F. G. GILMAN.

INUNDATION MATTERS.

To the Editor of the *Herald* :

I am gratified to learn through your columns that the city fathers are beginning to see the utility of my scheme for preventing the inundations. On the 13th of April last I wrote describing the means adopted to prevent inundations in other countries. On 18th January I forwarded supplements of same to the chairman of the Inundation Committee, a copy of which appeared in your issue of 25th January, suggesting that, as the floods were caused by an ice barrier forming below the city, it was advisable to rebuild the revetment wall or put another wall on the river side of same, commencing the foundation say ten feet outside the existing wall, and sloping the new wall inwards, so that it would come within six feet of the whole wall at the top of the same, the space between walls to be cemented with puddled clay; the new wall could be raised three or four feet higher than the old one, with ridged coping stones at the top of the same, coming to a sharp edge to prevent children walking on top. There would then be a protection for pedestrians in winter as well as summer. This sloping wall would have a tendency to raise the ice when shoving against it, and to relieve said wall of part of the pressure.

I further suggest that a new tunnel should be made to run parallel with the river, intercepting all present outlets, running from Point St. Charles along the centre of Mill Street, under the canal above the first lock, along Common and Commissioner Streets, joining the Craig Street tunnel at the lower end, and the whole to be carried to a point below St. Mary's current.

We should then require no pumping engines, as if the tunnel were carried far out into the deep water, it would be impossible for ice to clog it, and the "fall" through Hochelaga is sufficient to clear it at all times, thus saving an annual expense in attendance, fuel and repairs of a very large amount. Also that an earthen embankment be continued from the end of the revetment wall to all points from which the river has been known to flood the city, probably as high up as the River St. Pierre.

I have not been to any meetings of the Inundation Committee myself since Saturday week, as my prediction that the natural heat of the soil, acting on the proposed frozen sawdust bank, would allow the water to get underneath and float it away unless it was bolted down and clinched somewhere on the other side of the world, apparently gave offence.

In conclusion, I must apologize for not answering "Probs'" letter that appeared in your columns one day last week. I have not seen the paper he refers to. However, I seldom pay any attention to letters unless signed by the author.

Yours truly,

F. G. GILMAN.

773 Craig Street, 8th February, 1886.

128 PRINCE STREET, CITY, 16th January, 1886.

To the Special Committee on Inundations:

GENTLEMEN,—In the *Star* of 15th January you invite schemes or suggestions to relieve the city from the floods; and as I believe they can be effectually prevented I respectfully append herewith my ideas on the subject, which, if adopted, will prevent floods:

First. Take the level of the river as required for business purposes in the summer time. Then take the highest level the ice reaches in flood time—both levels between the town and St. Helen's Island. Next get a chart of the river bottom between the town and St. Helen's Island. You will then be able to join an estimate as to the extra amount of space required to allow the water to pass without jamming a block at flood time. You can then get space required for the flow of water by either deepening the river, taking away St. Helen's Island altogether, or only so much of it as would be requisite for the flood water. Removing part or all of St.

Helon's Island would be the least expensive, as you could employ prison labor for the greater part of the work.

I am, gentlemen, yours respectfully,

JOHN ARCHER.

GEOGRAPHICAL SOCIETY, QUEBEC, 27th March, 1886.

To the Editor of *The Star*.

SIR,—I wish to draw your attention to the state of the waters of the St. Lawrence, which enables mariners to sail from the Louise Dock, Quebec, to Cape Ray, Newfoundland, and so pass into the ocean. The Gulf of St. Lawrence is always navigable in spring until the Bay ice gets into the current, and so blocks its entrance with field ice; between Cape Ray and Bird Rocks this generally occurs at the end of April, but never in March.

The point, however, interesting to us in April is the ice blockade in the river between Quebec and Montreal, especially as it is believed, with our knowledge of modern science, it ought not to exist, and if not removable it is any rate preventable.

My argument consists in my knowledge of the element of water, its power to receive heat and to receive cold. The temperature of the river to-day is 34 degrees, 2 degrees above freezing; this is not the case with the land or the ice, they assimilate nearer the temperature of the air, which is frequently very cold, and in March, except when the sun is shining, rarely at a temperature of 34 degrees.

These facts being correct, we have to attribute this early navigation to the river having been kept clear of ice during the winter, and its preparation to receive solar heat early in March.

A shaft of water, at a temperature above freezing, being pushed and worked up and down by the tide, has an effect on the air, as the vapors can be both seen and felt, especially when this mass of water extends 100 miles inland, as is the case to-day.

The navigators of the Upper St. Lawrence ought to combine in winter, and, by the use of modern mechanical science, keep the navigation open by attacking the ice, where it can be done successfully, such as Point Lévis, the Chaudière, Point au Platon, the Lake, and so on, and prevent the ice blockades and subsequent spring inundations. A Dundee whaler could now, with the help of steam saws and dynamite, work its way through Lake St. Peter to Sorel, and so start by the use of the steamboat wave all the ice which Providence is going to send down in a few weeks—*Aide toi et Dieu t'aidera*.

I need not add, with open waters at Sorel in March, the men of Montreal will not retain their present honorable position in progressive science, if they cannot find some means of removing the impediments to their trade, and the evils of high waters to their city.

Get open waters both in Lake St. Francis and Lake St. Peter, and near as you can to Montreal, and the larger their volume the better, then feel assured two degrees above freezing will tell its tale, the night frosts will be diminished, whilst the day thaws will be increased, and your ice will rapidly disappear in the direction of Quebec, where it will be converted into water.

Remember thirty-four degrees is above freezing, and all that latent heat is covered up with ice in Lake St. Peter, and so protected from the sun's rays and all contact with the air, consequently causing delays and late navigation.

The captain of the "Alert" can do this service as easily as navigating Hudson Bay, if he was ordered to report in Montreal, and Canada would gain by having open ports in April instead of in May.

I enclose the Signal Service Report for 25th March, 1886, and

I have the honor to be, sir, your obedient servant,

W. RHODES, *Vice President Quebec Geographical Society.*

SIGNAL SERVICE REPORT.

QUEBEC, 25th March, 1886.

Cape Rosier—Thermometer 31. Dull and cloudy; variable winds; heavy open ice everywhere, moving north-east.

Manicougan—Dull and variable; no ice. Inward at 7 a.m. yesterday at Moisie, one schooner. Mail courier arrived 23rd, p.m.; reports shore ice from Point Esquimaux to Point des Monts broken up and Gulf clear.

Point des Monts—Dull and variable; no ice.

Anticosti—Thermometer 30. Light unsettled weather, with variable winds. South channel—No ice. North channel—Light close-packed ice in shore. South-west Point—Outward at 6 a.m., schooner "Java," several sealing schooners about island; schooner "Campbell" fitting out at English Bay for sealing.

Meat Cove—Dull; strong north wind; ice extends four miles off clear water outside.

Cape Ray—Clear and fine; light north-west winds; no ice. A schooner arrived this a.m. from the Gulf, with 1,100 seals.

QUEBEC, 21st April, 1886.

To the Editor of the *Quebec Mercury*:

SIR,—The conditions of the river in the harbor of Quebec have been so entirely satisfactory for the last month that I do not think they can be much improved. The grand battle against the floating ice by three steamboats during the winter has been so eminently successful, it will, no doubt, be renewed every year; and, though the steamboats lost screws and received other injuries, yet they demonstrated the fact that ice has to yield to superior force when guided by modern skill. In the St. Lawrence there appears to be two "points" between Quebec and Montreal, where the ice may jam in such a way as to become a public injury, viz., at the Chaudière and at Boucherville.

The Chaudière did not bridge this year, no doubt from want of material; as from the ice being kept in movement by the seven hours of falling tide, against the inflow of four hours, it would reduce the quantity of ice to pass through the narrows.

The formation of a bridge at the Chaudière is always uncertain; the nature of ice is to disperse and separate, to melt, but not to adhere; it is constantly trying to return to the condition of water and to flow instead of becoming solid. When an ice jam does form at the Chaudière it becomes so solid (twenty feet in thickness) that it only yields by melting and by the pressure of the lake ice. The effect of no bridge at Lévis and none at the Chaudière, was probably the breaking away of the Platon bridge, and consequently navigable water up to Three Rivers.

The Chaudière bridge can be prevented as easily as the Lévis, as it is the upper portion of the same water, and can be kept clear by the ordinary ferry boats, especially if directed to do so by the Harbor Commissioners of Quebec.

There appears to be a good deal of similarity in the history of these two ice jams, the Chaudière and the Boucherville, and I have little doubt a like treatment would lead to the same result which we claim at Quebec, of a better state of affairs; but the commencement must be made for Montreal at the point of the river where navigation ceased this winter, viz., at Three Rivers, and a passage or lane of water kept clear to the mouth of the Richolieu (Sorel). These water spaces are found in the Arctic seas, would follow the line of the current through Lake St. Peter, depending upon the flow of the water through the lake to keep the young ice running; in fact, run a ferry boat between Three Rivers and Sorel.

This year the breaking up of the ice on Lake St. Peter immediately relieved the inundation of Montreal; so it would appear if this had been artificially done, Montreal would have been saved a great misfortune. I would recommend Mayor Beaugrand to ascertain who is responsible for the navigation of the St. Lawrence, and if due

diligence has not been used to sue that department for a million dollars (this would no doubt bring on to the Public Estimates \$50,000, for the further improvement of the St. Lawrence) or to show cause why it is a dispensation of Providence and nobody is responsible.

In a previous letter (27th March) I have shown that the removal of ice from the surface of the water admits the rays of the sun, and heightens its temperature. This is to-day practically the case, as water coming into our harbor from the west shows a steady temperature of 34 degrees, whilst water coming from the east varies from 34 to 35 degrees.

The climatic effect is that we are sowing our gardens in Quebec on the 20th April, whilst for the last 49 years I have never been able to do anything before the 26th or 29th of April; our cows are also in the field, getting a half meal, and vegetation is far advanced.

The whole of this subject is of such national importance and of so great scientific interest, and by geographers, we shall become like Arctic navigators, surprised at our own want of courage, and at the facility with which we have abandoned to Providence an apparent impossibility.

I believe Providence does not expect us to wait until the sun removes the ice from our harbors, and I do not think Montreal will submit to be the last ice blockaded port on this continent. Even Hudson Bay hopes to compete with the St. Lawrence, and she will do so if she can solve the ice question.

I have the honor to be, sir, your obedient servant,
 W. RHODES, *Vice-President Quebec Geographical Society.*

TEMPERATURE of the water of the St. Lawrence, opposite-Quebec—Continued—1886:

April 9	Falling tide at	2.00 p.m.	.....	32°
do 10	do do	2.30	.....	32°
do 12	do do	2.30	.....	32°
do 13	Rising do	11.30	.....	36°
do 13	Falling do	5.00	.....	34°
do 14	Rising do	noon	.....	36°
do 14	Falling do	5.00	.....	34°
do 15	Rising do	1.30	.....	34°
do 16	Falling do	8.00 a.m.	.....	34°
do 16	do do	7.30	.....	34°
do 17	Rising do	3.30 p.m.	.....	34°
do 19	Falling do	8.15	.....	35°

Since the last return only two observations have been taken to establish the temperature of the ice in the Louise Basin. The result has given 32° in each case, the dates being the 9th and 10th of April. The ice is broken since the last date.

To Colonel Rhodes, with Mr. Verret's compliments.

SIGNAL SERVICE REPORT.

QUEBEC, 21st April, 1886.

- Cape Rosier—Thermometer, 41°; bazy, light north-east wind; no ice.
- Anticosti—Thermometer, 40°; cloudy and calm; no ice. The steamer "Titania" in the same condition as last fall, uninjured by ice.
- Cape Despair—Dull, north-west wind; no ice.
- Point Maquereau—Cloudy and warm; light west wind; no ice.
- Point Macuminao—Clear and fine; light west wind; heavy close packed ice everywhere.
- Cape Tourmentine—Clear and fine; strong south-west wind; ice two miles in extent, moving east.

Meat Cove—Thermometer, 60°; clear and warm; strong south-west wind; heavy open ice everywhere, moving east.

Low Point—Clear, fine and warm; strong south-east wind; ice everywhere, moving east.

Cape Ray, Newfoundland—Clear and fine; light south-west wind; fishing fair; no ice.

St. Pierre, Miquelon—Clear and fine; prospects of cold weather; light south wind; no ice near shore; some open ice visible far out.

216 St. MARTIN STREET, 18th January, 1886.

J. A. STEVENSON, Esq., City Hall.

DEAR SIR,—I read with interest the letter in Saturday's *Star* bearing on the floods, and having until recently lived on the river bank south of St. Helen's Island, and where my father still resides, I have seen considerable of the river's changes. The only letter in the *Star* bearing on the real points is the one written by Dr. Mount, and I quite agree with him that the present flood has been caused by the mild weather at the time he mentions.

Some of the writers suggest the removing of all the islands on the south shore. Now they are the only protection Longueuil has from being drowned out, as the ice anchors around these islands and prevents shoving to a large extent. One writer suggests removing Isle Ronde also, and, if we were Americans, St. Helen's Island would also be removed. It is the writing of such that prompts me to write this letter.

I would like to ask these gentlemen what caused the flooding of Laprairie Bay and also at Isle Perrot, and around the Cascades; was it the deepening the channel at those points? Certainly not. Some people think it is our harbor and river improvements that cause the recent flooding spring and fall, and of course the Government and the Corporation are supposed to spend a lot of money, in fact all they have to satisfy some people's imaginations. The harbor improvements have no more to do with it than the flooding of the other points I have before mentioned, and until we can control the weather, it is useless spending a lot of money on surveys.

Anyone that has watched the river as Dr. Mount has done, must agree with him, a great portion of the city can be made free from floods by closing the sewers that enter the river above the main Craig Street sewer at that point to have it pumped into the river. If all the islands on the river were cleared away, and of course the expense would be something enormous, we would still be as likely to flooding as at Isle Perrot. I can, if you wish, give a great deal of information about the forming and breaking up of the river. A good deal of the present cry out is of course against the Government.

J. G. HOLLAND.

QUEBEC, 15th January, 1886.

To Mr. ALDERMAN STEVENSON, Chairman Committee of Inundations.

SIR,—Pursuant to your public invitation will you allow me to make a remark or two.

If we look abroad and observe the course pursued by other cities, both in America and Europe, we shall find that any great question of construction is invariably committed to the handling of qualified experts, as they are commonly designated "civil engineers."

These highly educated, and what is more to the point, specially educated men, have not only for their guidance the judgment and intuitions resulting in their individual persons from long years of study and the traditions and axioms of their comparatively modern profession, but they obtain, by the time and labor which they are paid to exert and spend in the local investigation of the particular case, a view as complete as possible of its special nature and requirements.

Now, then, qualified men would by no means despise the evidence of former inundations, such as you wish to be laid before your committee. They would use such evidence, and form an enlightened judgment on its bearings and value. Then, they would go into the question of probable expense, and submit a scheme for the approval of the citizens and their qualified representatives.

In a cause like this there is something approaching to completeness, up to the point of an actual laying hold of the work. But when your honorable committee should have heard the evidence and the schemes of all the old residents who have been interested for years watching the ice floes, it will not, therefore, be in any position to decide upon the future course of the city in relation to security from floods.

Much of the evidence and all the schemes will want severe sifting, such as engineers only could give to them, and it is no disparagement to the honorable gentlemen of your committee that, in the absence of the qualifications alluded to, they will find their duties little other than burdensome, and in any event ineffective for a final decision. The expense of a scientific enquiry could not be very great, in view of the extreme urgency of the case, and it is to be earnestly hoped that a commission of experts will be appointed in the premises.

In Britain and in Holland, great works of protection have been in existence on the great waterways for centuries past, and on the Mississippi the subject is constantly receiving attention, and many important levees have been built; although, if our American neighbors would take up this question as a whole, and complete the banking as rapidly as might be, they would be immense gainers, for it is a work that should not be attempted in dribblets.

Asking your patience for these hasty notes.

I remain, dear sir, very respectfully yours,

HENRY HEMMING.

(Translation.)

ST. VINCENT DE PAUL, 21st January, 1886.

SIR,—Permit me to attract your attention to the subject of the floods in order to make known my opinion. Firstly, the floods are caused by the frasil which enters under the ice at the foot of the current, forming a hard solid mass from the bottom to the surface, which is called the vault; this vault extends from the foot of St. Helen's Island going northward, impeding the descent of the water in such a way that there is not enough space for the usual flow; the water is heaped back in the low places, and it is not until after the ice has risen above the city that the frasil diminishes and then the water takes its course again.

Sir, this is a plan which I propose to you: At low water I would have a channel dredged on the south of St. Helen's Island, 600 feet wide by 30 feet in depth and would construct a dam with openings at every 25 feet, and another at the head of the Island and a solid dyke, and by this means you will have a strong water power which could be utilized, and when the channel on the north side was blocked that on the south could be opened and I believe that would do a great deal to prevent the floods.

Your very humble servant,

DIDYME MELLEUR, *Pilot*.

GEORGE W. STEPHENS, M. P. P., appeared before the Committee and said:

The question of inundation has occupied the attention of the council at various periods since the year 1860.

During the term of the late Mr. McQuesten, city surveyor, and while I held office, various remedies were discussed and instructions given that in future the levels of all new buildings should be given above high water mark, and a plan was adopted of raising the grades of the streets. This was done in many instances.

There are two ways of getting rid of the inundation difficulty :

First—By sluice gates and receiving tanks at the outfalls of the main sewers, pumping the sewage during the stage of high water.

This could be done by establishing three pumping stations, one above the mill race, Point St. Charles, one at the Custom House, Point A Callière, a third at Colborne Avenue.

Intervening small sewers to be connected to the main sewer interiorly. The Point St. Charles district could be done very cheaply, as the aqueduct embankment with a little repair already affords protection to this district between the canal bank and the river side.

An experiment could be tried immediately with this section. The cost would be inconsiderable. The second remedy is to raise the streets throughout the inundated districts above flood level by depositing thereon the ashes of the city and the earth procured from excavations.

The expense could be met by a local assessment.

Under the local assessment by-law of Toronto, construction or reconstruction, but not ordinary repairs or maintenance of drains, sewers, roads and sidewalks, or for leveling, grading, paving, bridge building, curbing, sodding or planting, street sweeping, lighting and watering, are charged to the parties immediately benefited thereby. This plan is adopted for the most part throughout American cities. The adoption of this system would prevent what is called ward grabbing.

The reason why our older wards are neglected is that the taxes raised from them are largely spent in developing the unimproved parts of the suburban wards, most of which contribute lightly and draw heavily on the common revenue. If new works were, as they should be, charged upon the locality directly benefited, a large sum would be set free over the city for general purposes.

The water in the St. Lawrence opposite the city will rise to flood height as long as there are batteries or shoals for the ice to lodge upon, and weather which produces frazil.

The long wharf at St. Lambert ought to be blown up. This would take away one obstacle and reduce the swiftness of St. Mary's current.

The raising of the streets in the flooded districts would increase the value of property.

I do not think the flooded districts are rendered unhealthy by the mixing of the sewage with the water, or that much sewage is flooded into the cellars. The objectionable and unhealthy feature is the allowing the ice to remain in the cellars all winter, and the consequent damp and chilly cellars.

Sewage forms but an infinitesimal part of the flooding water.

As a matter of fact sewage air does not come into houses while the sewers are full of clean water to the arch of the sewer.

There being no vacant space in the sewer, there can be no formation of air there to be sent back into the houses.

A comparatively empty sewer may generate unpleasant air; a sewer full to the arch with water does not.

There is no necessity of spending any money on outside engineering talent, Messrs St. George and Brittain are perfectly competent to deal with the question practically.

GEO. W. STEPHENS.

(Translation.)

COTEAU DU LAC, 25th January, 1886.

DEAR SIR,—I have just seen by the newspaper of the 23rd that you have resolved to take measures to prevent new floods.

As it is every citizen's duty to assist in some manner, I hasten to suggest a method to you, a method which is inexpensive, very efficacious and the effectiveness of which I have had occasion to judge of for twenty years.

The floods come from the clogging of ice and of "irasil" coming together in too narrow channels. To stop its effects it is sufficient to make a boom (according to the customary expression) crossing the river where there is plenty of water, about two leagues higher up than the place where the clogging occurs. This method is for the autumn. For the spring floods it would be necessary to bar Lake St. Louis by the same means. In this manner it would cost very little and be very effective, according to twenty years' experience. For fuller information, if the method is adopted, please write me. If this is going to appear in the newspapers, I beg you not to give my name and sign it, "A Citizen of Coteau du Lac."

Yours, &c.,

G. PAIEMENT.

Alderman STEVENSON, Montreal.

P. S.—The effect which this "boom" would produce would be that the ice would make before the heavy frosts made themselves felt, so that when the ice had taken you would not have to fear the water because it would have already taken its course under the already solid ice; briefly, for the Boucherville Islands, the channels would be always free and the water would not be impeded in its flow.

Yours,

G. PAIEMENT.

(Translation.)

MONTREAL, 25th January, 1886.

SIR,—Since the Floods Committee invites everybody to give the help of his ideas upon the means to be taken to remedy the evil which is called "the floods," I will permit myself to submit to you very humbly my plan, believing it good and sure, above all for the ordinary floods, that is to say to stop the entrance of the water into the cellars by the pipes which connect with the St. Lawrence.

In the first place I propose to take away the pipes which discharge along the river, so that there should no longer exist on the banks of the river those openings by which the water, forced up by the rising of the St. Lawrence, finds this means of getting into the cellars. These pipes once taken away, place an immense pipe able to receive all the drains of the city, and carry it down below the city far enough, so that the rise of the water cannot reach up to the city.

Perhaps you will find it better to drain the city towards the side of the River des Prairies, but I think that it would be better to do so down along the St. Lawrence.

By this means we are sure to stop every ordinary flood. We shall then have to master the great floods like those of this winter. The water having overflowed Point St. Charles, I can only see the construction of walls at these low places, or if the thing is possible, to build large gratings by which this water could also be let into your large pipe. That, my dear sir, is the humble opinion of

Your obedient servant,

CHARLES DESJARDINS.

JACQUES GREENIER, Esq.

(Translation.)

MONTREAL, 25th January, 1886.

To COLONEL A. A. STEVENSON, Chairman of the Municipal Commission charged with the question of the Floods of the St. Lawrence.

SIR,—I have read the methods set forth by the Committee on the Floods; these methods, more or less ingenious, do not, however, bear an attentive examination, and they are generally beside the question. And yet the problem to be solved is simple, and I have not even the merit of discovering its solution.

Many cities have found themselves in the same plight as Montreal, it may be with watercourses less considerable than the St. Lawrence, but at bottom the principle remains the same.

The heaping up of the ice is caused by the small velocity of the current; this small velocity is again partly broken by St. Helen's Island. The ice thrown from the Lachine Rapids into comparatively still water, moves slowly down as far as Longueuil and is not long in piling up and producing those ice mountains so often observed in the St. Lawrence. The only practical and the cheapest method of creating a quicker current, and at the same time enlarging the bed of the river, is dredging. This is a very simple operation nowadays, when as a consequence of the accomplishment of the Suez and Panama Canals, industrial art possessors those powerful dredges which, with so little manual labor, do so much work. I do not hear anything said of well planned dredging following along a profile established by soundings, and creating in the centre of the river a channel sufficiently deep to take the bulk of the water and create this precious current which will carry away with it in its course, according to its sphere of action, the drifting ice floes.

Two or three dredges would suffice to bring this work to a good end; but it is absolutely necessary that these should be powerful dredges, on the model of those which dug out Suez and Panama, for ordinary dredges would not do appreciable work.

Raising the level of the streets, besides being very costly, would involve the unhealthiness of all the houses now built in this part of the city.

If, sir, you approve of these opinions, although they are rather summary, and if they have any interest for you, I could undertake the execution of profiles and soundings, having already carried out similar works, and could then furnish you with detailed plans, from which it would be easy to calculate the amount of excavation to be executed, according to a uniform plan of bottom. This amount together with the limit of time would serve to determine the number of dredges necessary.

I would like to carry out this work under the eminent direction of the members of the city council, and I would be glad if you would be so kind as to take into consideration my offers of service, not as a contractor, but as an executive officer under your orders.

If you wish to, sir, you might apply for references to Doctor d'Orsoniens, whose distant relation I am and who knows my family well.

I have the honor, sir, to beg that you will believe me to be

Your obedient servant,

MAINE.

(Translation.)

Mr. CHARLES LÉGER, Pilot, of Lachine, P. Q., gives his opinion upon the causes of the periodical floods.

MONTREAL, 13th July, 1886.

Besides the information which I have given the Special Committee on the floods, I desire to add that the causes of the periodical floods at Vaudronil and at Isle Perrot, have nothing to do with the floods at Montreal, which are caused as a consequence of the descent of the ice of Lake St. Louis, and I am in a position to prove positively what I affirm.

Between Isle aux Cheveaux and the last lock of the Beauharnois Canal, there is to be found a fall known by the name of the Jument Blanche (white mare). This fall has a hollow which engulfs everything that passes there.

About the 10th February, 1885, a storm came up and a considerable quantity of snow and frasil completely filled up this cavity. This fact re-occurs every seven or eight years towards the end of January and the beginning of February. Some forty years ago this fact occurred towards the end of the month of February, when the water flooded my father's building on Ile Perrot.

Towards the end of the month of January and the commencement of the month of February when the cavity in the Jument Blanche fall is filled up with snow and

frasil, as above mentioned, the ice rises over the lower look of the Beauharnois Canal as well as over the Bris de l'Eau rock, situated at the foot of Isle aux Cheveaux, and this causes the delay in placing the lightships in this neighborhood and turns aside the natural course of the St. Lawrence towards the Sicke above Isle aux Cheveaux, and passes over the point of the Cascades and floods Ile Perrot as well as Vandreuil. The water continues its course by the little river of St. Eustache.

The ice of Lake St. Francis, which is 33 miles in length and of a width of 6 miles has to come down through a space of a quarter of a mile between Coteau and Clark's Island.

This ice is rotten before coming down and does not contribute at all to the floods of the city of Montreal.

his
CHARLES X LEGER.
mark

Witnesses—CHARLES ARNOLDI, E. CHRISTIE.

TO THE CITY OF MONTREAL.

The Special Committee on Inundations respectfully report,

That as directed by the council, they have been engaged, during the past three months, in carrying on the work necessary to test the feasibility of the plan proposed in a former report, for the protection of the city from sewer floods. This consisted in constructing puddle-dams near the outlets of the main sewers leading to the river, with the view of preventing the rising waters, on the breaking up of the ice, from backing up into the street drains, and thence into the cellars of business places and streets in the low-lying districts.

The outflow of the sewage being thus obstructed, pumping stations were required to pump the sewage over these dams into the river.

It was deemed advisable this year to limit the work to those sewers west of the custom house, which receive and discharge the sewage and surface water of the St. Ann's ward, that being the district which suffers most from these periodical floodings although the portions of St. Antoine, West and Centre wards, which drain through McGill, St. François Xavier and other streets into the William Street tunnel (having its outlet in front of the custom house) likewise enjoyed the benefits resulting from this undertaking through the blocking of St. François Xavier Street drain at the foot of that street and its connection, with the pumping cut by a wooden box drain 2×2 and 60 feet long, which your committee caused to be constructed.

Six pumping stations were established: No. 1 being in Commissioners Street, near the custom house, which received the contents of the sewers of William, McGill and other streets as far east as St. François Xavier. The sewer at this place is 14 feet six inches wide and 12 feet deep. The cut was 40 feet long 16 feet wide and 18 feet deep (with two side cuts 10 × 8 × 16) in which was constructed a solid dam of puddle clay, 20 feet on the surface, tapering to 12 feet at the bottom and properly secured by heavy timbers, with a flume and sluice gate of the full dimensions of the William Street tunnel; the other twenty feet required for pumping and discharge basins. In excavating here, an object of great interest was discovered, the existence of which seemed to be known to very few, viz.: the ancient stone bridge, erected during the occupancy of the French, to span the open creek, which at that time ran along the present line of Commissioners Street. The masonry seems as strong and substantial to-day as when first erected.

The cut at No. 2 station, in Mill Street, near the canal tail race, at Tate's dock, was 41 feet long, 24 feet wide, and 17 feet six inches deep, with a dam of blue clay, flume and sluice gate, protected by timbers 20 feet 6 inches by 8 feet. This station received the contents of a large number of drains in Point St. Charles.

Nos. 3, 4 and 5 stations were located at the foot of Forfar, Conway and Britannia Streets.

No. 6 station, in St. Etienne Street, near the abutment of the Victoria Bridge.

For the further protection of this part of the city, it was found necessary to construct an earth embankment from Forfar to Britannia Street, 477 feet long, average depth 7 feet 6 inches, average width 9 feet 6 inches, with a small flume and flood gate in surface drain on Britannia Street, and a similar embankment, south of that street, on river front, 12 feet long, 4 feet wide, 3 feet deep, with a sluice and gate. It was also found necessary to erect embankments at various places above Victoria Bridge on the rifle ranges and the Nun's farm. These consisted of:

1. A dam and embankment at top of ranges, 22 feet long, 20 feet wide, and 7 feet deep, with flume and flood gate, the flume being 20 feet long, 2 feet wide, and 3 feet deep;

2. A long embankment, about 350 feet, average width 5 feet 6 inches, average depth 5 feet 6 inches, with one flume and gate, the flume being 20 feet long, 1 foot 10 inches wide, and 2 feet deep;

3. A second embankment, length 273 feet, average depth 4 feet, average width 5 feet, with flume and flood gate, the flume being 14 feet long, 1 foot 4 inches wide, and 1 foot 9 inches deep;

4. A dam and bank at back of butts 18 feet long, 10 feet wide, 6 feet deep, size of flume 13 feet long, 1 foot 10 inches wide, and 1 foot 5 inches deep;

5. A dam in front of butts, 12 feet long, 7 feet wide, 7 feet deep, with flume and gate, size of flume 13 feet long, 1 foot wide, and 1 foot 2 inches deep;

6. A bank and dam north of rifle ranges, 12 feet long, 12 feet wide, 4 feet deep, with flume 13 feet long, 1 foot 4 inches wide, and 1 foot 5 inches deep;

7. A dam and embankments on the Nun's farm, 24 feet long, 12 feet broad, 6 feet deep, with flume 21 feet long, 3 feet wide, and 2 feet 6 inches deep;

8. An embankment and dam also on the Nun's farm, 50 feet long, 8 feet wide, 3 feet high, with flume and gate; flume 12 feet long, 12 inches wide, and 12 inches deep.

The work was not given out by contract, but was done under the immediate superintendence of Mr. Richard McKeown, who carried it out to the entire satisfaction of the committee. The same remark is applicable to Mr. James Wright, engineer, who had charge of the machinery.

The committee had the advantage of the co-operation of Messrs. Walter Shanly, M.P., C.E., John Kennedy, harbor engineer, Louis Lesage, superintendent Montreal waterworks, P.W. St. George, city surveyor. F. B. Lavallée, deputy city surveyor, also took an interest in the work and gave very valuable assistance.

Instead of leasing or hiring pumping machinery, as had been originally intended, your committee found it would be more in the city's interest to purchase the pumps required.

Accordingly they procured from the Morris Machine Works, Baldwinsville, N.Y., five Heald and Sisco No. 12 centrifugal vertical pumps, each capable of discharging 10,500 gallons per minute. Three of these were placed in No. 1 out at Commissioners Street. The total capacity of the five being 75,000,000 gallons per day of 24 hours. Powerful hand pumps of modern pattern were sufficient for stations 3, 4 and 5, and a 6" rotary steam pump, owned by the road department, was used in No. 6.

The Grand Trunk Railway Company gave your committee valuable assistance by granting the use of three locomotives, on which considerable alterations were made to fit them for driving the large pumps on Commissioners and Mill Streets. They answered the purpose admirably, and your committee would recommend that, on examination and approval by an expert, they be purchased by the city and retained for similar work in future years. They can be procured for \$1,250 each, as they stand at present, including all charges for the alterations made to adapt them for this work.

The committee consider that it would be impossible to get the same amount of motive power in any other way for a like sum, and they therefore consider that the acceptance of the terms named in the letter to Mr. Wallis, mechanical superintendent, G.T.R., which is submitted herewith, would be most advantageous to the city. In the event of the council not purchasing these locomotives, the cost of their alteration and their return to the G.T.R. works will have to be defrayed by the city.

Whatever plans or schemes may ultimately be adopted for the prevention of floods, it is quite evident that, so long as the water in the river does not rise higher than the revetment wall, the pumping of the sewage furnishes an effectual and comparatively inexpensive method of keeping the cellars and streets free from inundation, and will doubtless be continued in future years. The experiment of this year, notwithstanding numerous difficulties and drawbacks, proved as satisfactory as the most sanguine could desire.

There is ample evidence to show that for eight or ten days previous to the 17th of April, the water in the river kept steadily rising, and attained a level which, but for the damming and pumping of the sewers, would have flooded nearly all the cellars in St. Paul, Commissioners and the lower portions of many other streets, in the business part of the city, as well as in St. Ann's ward.

Scores of people testify that in former years, with the water in the river at a similar height, they had been inundated to a depth of several feet, whilst this year, up to the day above named, they were perfectly dry. On that day, however, the water overflowed the river banks and revetment wall in a disastrous deluge, having risen to the unprecedented height of 44 feet 4 inches above the bottom sill of the lower lock of the old Lachine Canal (that being the datum line adopted by the Harbor Board for that purpose). In the great flood of 1861, the depth of water was 41 feet 8 inches, so that this year exceeded 1861 by 2 feet 8 inches. From Saturday, the 17th, at noon, until Tuesday, the 28th, when the ice jam in the river gave way, pumping operations were, of course, suspended. But as soon as the water commenced to recede, work was again resumed and within two or three hours the sluice gates in all the flumes were opened, and the pumps were kept in operation until the end of the week.

The expenditure already made in connection with this amounts to about \$8,000 and your Committee estimate that it will require between \$4,000 and \$5,000 to cover outstanding accounts and the work yet to be done. Should the council determine to purchase the Grand Trunk Railway locomotives, \$3,750 will require to be added. An account of this expenditure, and also a statement or inventory of the plant now in possession of your Committee is appended to this report. The value of the machinery and plant on hand, exclusive of the locomotives, is between \$3,000 to \$4,000, all of which will be available for use in future years.

Workmen are at present engaged in restoring the rifle ranges and Nun's farm to their former condition. The work will be completed in a very few days. The out at Mill Street Station was found to be in a most unsuitable place, the soil there being a sort of quicksand, and there being a number of old flumes and pipes at that particular spot. There is a much better location 150 feet higher up the street, which is clear of all obstructions, and which will have to be adopted in future years. The pumps, framing, &c., were therefore taken up, and the brickwork of the drain restored.

Through the kindness of Mr. Conway, the pumps and other plant used at that station have been stored in the Government yard adjoining.

The pumps at Commissioner Street station have not been removed. Everything is left just as it was after the flood, awaiting the decision of the council as to what action is to be taken on the recommendations of the city surveyor, which accompany this report. Something must be done immediately, however, to remove the large bank of earth, so that the people in the neighborhood may not have cause of complaint.

Recommendations by the Committee.

Your committee are of opinion that the council should adopt measures for carrying on permanently the work undertaken by them this year, and as everything appertaining to streets and sewers properly comes within the jurisdiction of the Road Committee, your committee think that the machinery, plant and other material

now under charge of your committee should, at once be handed over to the Road Committee so as to enable them to take steps for the protection of the present stations and to perfect arrangements during the summer for next season's work. The special committee could then be discharged from further obligations in connection with this matter.

The experience gained by your committee, in connection with these foregoing experiments, warrants them in recommending for the consideration of the council:

1. That properly constructed flood gates be placed during next summer at the mouth of all the main sewers, to answer the same purpose as the puddle did this spring, and the requisite pumping machinery erected in their vicinity, to empty the sewage into the river.

Care should be taken that one or two extra pumps should always be available in case of accident. Craig Street tunnel emptying at the foot of Colborne Avenue would require, say two No. 15 pumps, having a discharging capacity each of 16,500 gallons per minute.

2. Commissioners Street station through which William Street tunnel is discharged should have an additional No. 12 pump, making four in all.

3. Forfar, Conway, Britannia and St. Etienne Street drains should be connected with Mill Street station, and two additional No. 12 pumps supplied, making four in all, as at Commissioners Street.

The cost of these works is estimated by the City Surveyor's report (hereunto annexed) to be in the neighborhood of \$10,000. This amount could with great propriety be taken out of the drainage loan, inasmuch as the greater part of the work in question would in any event have to be done by the road department at an early date.

Schemes suggested by Citizens for remedying the evil.

Numerous plans or projects have been laid before your committee respecting divers works in the bed of the river, which their respective advocates claim would tend to prevent, or at least greatly mitigate, the evils of inundation. Amongst these are:

1. The construction of piers or breakwaters across the foot of Lake St. Louis, Lake St. Francis, or other points above the Lachine Rapids. These piers, it is claimed, would have the effect of preventing the ice breaking away in the fall; when the ice bridge is forming, and would also hold it later in the spring than at present.

If these expectations were realized the channel in front of and below the city, would be less likely to be choked in the fall, with the floating ice, which during a thaw, comes down in great quantities, from these two lakes, and would render it more likely that the ice in the harbor and its vicinity would get away in the spring before the lake ice comes down. It is also claimed that the construction of these piers would be very beneficial to all the municipalities below Lachine, on both sides of the river. Your committee deem this project to be one of great importance, meriting an early and earnest consideration at the hands of the Governments and the Council.

2. The removal of the old Railway Wharf at St. Lambert's, and otherwise clearing as well as deepening the south channel of the river from Victoria Bridge to Longueuil.

3. The straightening, deepening and widening of the ship channel as far as Longue Pointe.

4. The removal or shortening of the long wharf, which, it is claimed, projects unduly into the channel of the river.

5. The removal of Isle Ronde, and the clearing of the channel in the neighborhood of the Boucherville Islands.

6. The blowing up of the ice bridge, at different times and places during the spring months.

With regard to the above, your committee have only to say that as they relate to matters beyond the jurisdiction of the council, the river being entirely under the control of the Government, they would urge upon the council to obtain a conference with the Government on the whole subject. The committee hope that the projects above enumerated will be carefully considered by the Board of Engineers, which, it is understood, is now or shortly to be appointed.

Final Recommendations.

Your committee are, however, of opinion that no time should be lost by the council in taking measures to secure :

1. The adoption of higher levels throughout the low-lying districts of the city, which new levels should be gradually worked up, under the supervision of the Road Department, at the expense partly of the city, and partly of the localities benefited.

2. The reconstruction, and at a higher level, of the worn-out revetment wall, together with the construction of levees around the whole of the Point St. Charles district, an equitable proportion of the cost of these works to be borne by the Dominion out of the general revenues of the country.

3. The application to the Dominion and Local Parliaments, now in session for legislation to enable the Governor in Council, in conjunction with the city council to initiate and complete the necessary works, and also to authorize the council to negotiate a loan for the city's share of the expense.

In conclusion, your committee hope and trust that the general interest which has lately been awakened on this most important subject will not be allowed to subside, and that the council, having at last taken the matter in hand, and accomplished something in the right direction, will never slacken its efforts until some effective means are found to remedy to a great extent, and in time entirely prevent, the recurrence of those disastrous inundations which periodically cause incalculable loss to merchants and manufacturers, and produce indescribable misery and suffering in the homes of the working classes whose dwellings are situated in those portions of the city more immediately affected thereby. Montreal in the past, has been equal to every emergency, and her citizens and city council can surely never rest satisfied until all danger of inundations is entirely removed.

The whole nevertheless respectfully submitted.

A. A. STEVENSON, *Chairman,*

M. LAURENT,

J. McSHANE, JR.,

ROBERT PATON McLEA,

Representing the Board of Trade.

D. A. WATT,

Representing the Corn Exchange Association.

COMMITTEE ROOM, CITY HALL, MONTREAL, 10th May, 1886.

TO THE CITY OF MONTREAL.

The Special Committee on Inundation respectfully report :

That the expenditure incurred in connection with their work from the beginning of February to date amounts to \$12,700 or \$4,700 in excess of the original appropriation.

In addition to this, however, there is the question of the locomotive to be considered. The Grand Trunk Railway Company offers to sell the three engines furnished to your Committee for \$3,750, and should it be decided to take them the total additional appropriation required will be \$8,500.

Should the city not purchase the three engines the sum of \$1,665 will have to be paid for repairs and alterations which had to be made to them; \$30 for the use of them, and \$300 for removing them back to the company's yard, or \$1,000 in all, which would be practically lost to the city.

Your committee could therefore recommend their purchase and assumption by the Road Committee, together with the other plant remaining on hand, amounting to \$3,827, as per inventory; that your committee receive a further appropriation of \$3,600 as above stated, to pay for the engines and all outstanding claims, and that the Road Committee be directed to carry out such permanent inundation work as may be determined upon in accordance with the city surveyor's report.

The whole respectfully submitted.

A. A. STEVENSON, *Chairman,*
 M. LAURENT,
 J. McSHANE, JR.,
 ROBERT PATON McLEA,
Representing the Board of Trade.
 D. A. WATT,
Representing the Corn Exchange Association.

CITY HALL, MONTREAL, 14th June, 1886.

TO THE CITY OF MONTREAL.

The Finance Committee respectfully report:

That, as directed by the council, they have considered the accompanying report of the Special Committee on Inundation for a supplementary appropriation, and that they concur in the recommendation therein made.

The whole nevertheless respectfully submitted.

J. GRENIER.
 J. H. MOONEY,
 JEREMIE PERRAULT.
 WILLIAM FARRELI.

COMMITTEE ROOM, CITY HALL, MONTREAL, 17th June, 1886.

Reference No. 70,675.

MEMO:—Answer the letter from the City Council or its committee thus:
 That the suggestion therein made has received the consideration of the Minister and has been submitted by him to Council, but that the Government do not see that the Dominion at large has any interest in the proposed levee at Point St. Charles, and therefore do not feel that they could recommend to Parliament a vote of money for that purpose. But that when the Commission of Engineers appointed by the Government report finally on their examination and the causes of the flood, should there be any Dominion work recommended, the Government will not fail to give to such suggestions their best consideration, with the view, if possible, of recommending the matter to the favorable consideration of Parliament.

13th July, 1886.

H. L. L.

Reference No. 71,313.

(Translation.)

LAPRAIRIE, 5th October, 1886.

To the Honorable Sir HECTOR LANGEVIN, Minister of Public Works, Ottawa.

SIR,—I have the honor to transmit to you herewith enclosed a copy of a resolution passed yesterday evening, by the municipal council of the village of Laprairie, relating to the ice-breakers in Laprairie Bay.

I have the honor to be, sir, your most obedient servant,

A. J. A. ROBERGE.

(Translation.)

EXTRACT from the minutes of meetings of the municipal council of the village of Laprairie.

"At a general meeting of the municipal council of the village of Laprairie, held at the usual place on Monday, the fourth October, eighteen hundred and eighty-six.

"It was moved by councillor Ambroise Hébert, seconded by councillor Octave Dumontel, and unanimously resolved;

"That this council has learned with extreme satisfaction the decision of the Government of the Dominion of Canada, with reference to the immediate construction of ice-breakers in Laprairie Bay;

"That in the opinion of this council, the carrying out of these important works has not been commenced a day too soon, seeing that every winter a considerable portion of this village is threatened with imminent ruin, and that only just time enough is left to complete the work before the ice takes;

"That this council hastens to seize the first occasion which has offered to express its lively gratitude to the Honorable Minister of Public Works, Sir Hector L. Langevin, for having so kindly considered in a favorable manner the petitions of this council, which have been so effectively supported by the members for the county of Laprairie in the Federal and Local Houses.

"That while thoroughly approving the appointment of and the works hitherto accomplished by the commission on the floods, this council solicits a special enquiry into the means of preserving this village from the floods caused by the taking of the ice, and a separate report containing an estimate of the works to be carried out to prevent such floods;

"That this council would be highly honored and very happy at the same time to receive a visit from the Honorable Minister of Public Works, a visit which would enable him to note the progress of the works commenced and would enable the residents of this locality to express personally to him their gratitude.

"T. A. BRISSON, *Mayor.*

"A. J. A. ROBERGE, *Secretary-Treasurer.*

"True Extract,

"A. J. A. ROBERGE,
"Secretary-Treasurer."

(Translation.)

The Honorable SIR HECTOR L. LANGEVIN, K.C.M.G., O.B., Ottawa.

SIR,—The secretary of our municipality, Mr. Roberge, has received instructions to send you copies of certain resolutions adopted yesterday by the Council of Laprairie. The fourth of these resolutions necessitates some explanation which I hasten to give you in order that no delay may be incurred in giving it effect, provided always that you deem it opportune to accede to our request.

The village of Laprairie suffers not only from the great floods in the spring. In winter when the ice takes, the water covers over a great part of it, and afterwards freezes and causes considerable injury to property. The existence of the old embankment of the "Montreal and Champlain" railway, and of a levée constructed by the municipality, would allow the village to be effectively protected against the inconveniences referred to, and this at a comparatively small cost. The corporation is disposed to contribute to a certain degree towards this expenditure, but the important point at the moment is to know the exact amount of it. In order to arrive at that it would be sufficient to take some levels for a distance which is not very considerable and to calculate the cost of the embankment to be made—the work of a day or two at most for the Government Engineers. That, sir, is what the fourth one of the resolutions forwarded to you requests on your part. The kindness with which you have hitherto treated Laprairie leads me to hope for a favorable reply from you.

I have the honor to reiterate the invitation which has been given you to visit our locality. In the absence of other display, you will find there a population grateful for what you are doing for it.

I remain, sir, your obedient servant,

T. A. BRISSON.

LAPRAIRIE, 6th October, 1886.

Reference No. 72,307.

HARBOR COMMISSIONERS OF MONTREAL, SECRETARY'S OFFICE,
MONTREAL, 8th November, 1886.

SIR,—Your letter of the 2nd inst., enclosing copy of a report from the Montreal Flood Commission, under date of the 28th ult., has been duly considered by the Commissioners.

In reply, I am to say, that the Commissioners are prepared to place four of their tugs at the disposal of the Department, with the necessary ice breaking prows (at an estimated cost of about \$1,000), free of all charge.

The working expenses, &c., of course will have to be arranged for by your Department.

As there is very little time left before the close of navigation to properly prepare the tugs, the Commissioners would respectfully ask as early an answer as possible.

I have the honor to be, sir, your obedient servant,

H. D. WHITNEY, *Secretary.*

A. GOBEL, Esq., Secretary Department of Public Works, Ottawa.

Reference No. 72,454.

CERTIFIED COPY of a Report of a Committee of the Honorable the Privy Council, approved by His Excellency the Governor General in Council on the 10th November, 1886.

On a memorandum dated 3rd November, 1886, from the Minister of Public Works, representing that Parliament at its last Session, made the following named vote: "Examination in connection with spring floods at Montreal and vicinity, \$5,000," on the understanding that a like sum was to be contributed by the City of Montreal, and that of the amount so voted the sum of \$4,000 has been advanced to the Commissioners appointed to enquire into the causes and the means of prevention of such floods, thus leaving available a balance of \$1,000.

The Minister further represents that the Commissioners now apply for a further advance of \$3,000.

That the chief engineer of his Department to whom the matter was referred, suggests that the advance so applied for be made. The Minister recommends that authority be granted in accordance with the suggestion of his chief engineer, and that to enable the proposed payment of \$3,000 to be made, a special warrant of His Excellency the Governor General do issue for the sum of \$2,000, the Minister of Finance having reported there is no Parliamentary appropriation from which the same can be defrayed, and that a like amount be placed in the Supplementary Estimates to be submitted to Parliament at its next Session and the said sum of \$2,000 to be recouped to the Government from the amount to be contributed by the City of Montreal.

The Committee submit the same for Your Excellency's approval.

JOHN J. MCGEE, *Clerk Privy Council.*

To the Honorable the Minister of Public Works.

Reference No. 72,486

CITY CLERK'S OFFICE, CITY HALL, MONTREAL, 16th November, 1886.

SIR,—I have the honor to transmit to you herewith an extract from the minutes of a meeting of the Finance Committee, held on the 11th November inst., accompanied by an extract from the minutes of the City Council with reference to the experimental measure suggested by the commissioners appointed to enquire into the causes of floods at Montreal.

I have the honor to be, sir, your obedient servant,
CHAS. GLACKMEYER, *City Clerk.*

A. GOBEIL, Esq., Secretary Department of Public Works, Ottawa.

EXTRACT from the minutes of a meeting of the Finance Committee, held on the 11th November, 1886.

The committee having considered the resolution of the special Committee appointed to consider the report of the commissioners on inundations, suggesting the keeping open of the channel between Sorel and Three Rivers during the winter, by which resolution the Committee concurred in the appropriation of two thousand dollars as the city's contribution towards the cost of the proposed experiment, it was unanimously resolved to concur in the said resolution.

Certified,

CHAS. GLACKMEYER, *City Clerk.*

EXTRACT from the minutes of a meeting of the Special Committee on floods, held on the 10th November, 1886.

Submitted and read the letter of A. Gobeil, Secretary Public Works Department, Ottawa, and the accompanying report from the Commissioners suggesting the propriety of keeping open the river between Sorel and Three Rivers in winter as a means of preventing the floods.

The Committee having duly considered the said report it was resolved to concur in the suggestion, and that the Finance Committee be asked to appropriate the sum of \$2,000 as the city's contribution towards the cost of the experiment.

Certified.

CHAS. GLACKMEYER, *City Clerk.*

EXTRACT from minutes of Council, monthly meeting, Monday, eighth day of November, 1886.

Submitted and read a letter from A. Gobeil, Secretary of the Department of Public Works, Ottawa, transmitting copy of a report of the Commissioners appointed to enquire into the causes and the means of prevention of floods at Montreal.

On motion of Alderman Grenier, seconded by Alderman Stevenson, it was resolved, that said letter and report be referred to a special Committee composed of Aldermen Laurent, Donovan, Mooney, Rolland, Hamelin and the mover and seconder, with power to appropriate, subject to the sanction of the Finance Committee, a sum not to exceed \$2,000 towards the experimental measure suggested by the Commissioners, and deal generally with the question of the periodical inundations at Montreal.

Certified.

CHAS. GLACKMEYER, *City Clerk.*

Ref. No. 72,668.

(Telegram.)

MONTREAL, QUE., 25th November, 1886.

To SIR HECTOR LANGEVIN.

Inundation Committee very anxious to know if Government will take immediate action to keep river open as suggested by Commissioners. Early answer requested.

C. GLACKMEYER, *City Clerk.*

(Telegram.)

CHIEF ENGINEER'S OFFICE, PUBLIC WORKS DEPARTMENT,
OTTAWA, 25th November, 1886.

To O. GLACKMEYER, City Clerk, Montreal.

The Government will contribute two thousand dollars towards experiment of keeping St. Lawrence open as proposed by Flood Commission.

Ref. No. 72,755.

(Translation.)

SIR,—Following and as a supplement to the report of a certain exploration made lately at Laprairie by Mr. Lafleur, I take the liberty of submitting for your consideration some facts suitable for deciding definite action on the part of your department, if such is its intention.

Although the season is rather advanced, I do not see any serious obstacle to the accomplishment of these works, particularly as to the portion comprised between the two icebreakers under construction. An embankment of the nature of that which is suggested by your humble servant would be the fitting complement of the protection works undertaken at the south west extremity of our village, the portion which has been so seriously tried especially for some years past. This embankment—or rather this dyke—would suffice—with very rare exceptions—to prevent the ice entering the low part of the village. It would advantageously take the place of the building of a third ice-breaker between the two first, the necessity of building which might well be recognized before long. If the officers of the Department will be good enough to recall it to their remembrance, the people of Laprairie were given to understand that at least two complete ice-breakers would be put up this year. However, there is every right to consider that only one and a half are under construction, seeing the small dimensions of one of the two. I do not mention these matters by way of complaint. On the contrary, I have only to express to you our gratitude for the promptness with which you have come to our aid and for the deference which the officers of your department have shown me under all circumstances as Mayor of the place. For my own part, I wish nothing so much as to avoid the reproach of requesting unreasonable things and of leading the Government into useless expenditure. I feel myself perfectly at ease in this respect and I am sincerely convinced in making the present demand that the works which are the object of it have a great importance, that the cost of them would be quite moderate, and that their execution would result in preventing heavier expenditures later on.

From the point of view of the floods, the carrying out of the works asked for would furnish the proof that Laprairie could be preserved from the ravages caused by the floods of the St. Lawrence at a comparatively small cost. In any case, the plan now submitted for the study of the engineers of your department, and which refers specially to the winter floods, has considerable importance, not only for Laprairie, but also for the whole district of which this place is the chief town. The carrying out of it would have as its effect not only a sensible increase in the value of property at Laprairie, but it would also ensure at certain seasons to the people of the surrounding parishes communications of which they are deprived in the existing state of affairs.

To sum up, sir, I believe I can affirm that reasons of public interest are strongly in favor of this project, the realization of which is as easy as it is little burdensome for the Government of the Dominion of Canada. I therefore express, in the name of the people of this district, the ardent wish to see it accomplished during the present season, and I am, with the greatest respect, sir, your most obedient and very grateful servant,

T. A. BRISSON, Mayor.

The Honorable Sir HECTOR L. LANGEVIN, K.C.M.G., C.B., Minister of Public Works.
LAPRAIRIE, 25th November, 1886.

Reference No. 75,274.

MONTREAL FLOOD COMMISSION, MONTREAL, 10th March, 1887.

SIR,—The commissioners, on account of the severity of the past winter, the strength of the ice covering below this city, the large amount of snow remaining at this date and the possibility of a rapid thaw accompanied by heavy rains producing a breakup while the ice is yet very strong, have had under their consideration the propriety of an experiment with explosives for the purpose of weakening the ice about and below Longue Pointe, where they believe its long continued firmness last April was the chief cause of the excessive flood in that month. As this is the only means of amelioration which is now available, against the possible effects of the approaching breakup, they have come to the conclusion that, however uncertain may be the result, the experiment ought to be made, especially as it will not be attended with very great expense. It is possible that the river may break up and the ice depart without producing a flood, as is the case in the majority of years. The spring floods in the last quarter of a century have occurred always in the month of April, and only in the years 1861, 1865, 1869, 1885 and 1886; the last reaching 2 feet 9 inches higher than any of the preceding ones. This gives five spring floods in 25 years, an average of one in five years; but, since they occurred in both 1885 and 1886, another is possible this year. It is impossible to resort to explosives with any hope of success after the movement of the ice has developed the probability of a flood.

They propose therefore to break up with explosives the field ice in the main channel extending from above Longue Pointe towards Isle St. Thérèse, upon which they ask authority to expend a sum not exceeding \$3,000. The ice, of course, cannot be removed from the channel, but, if so broken up, the better exposure to the influences of advancing spring and the wear of the current would, they believe, so weaken it, that it would give way before the down coming ice, and allow the latter to be distributed over a greater length of river, thus forming a longer and lower temporary dam.

As the authority of the Dominion Government will be required for any such experiments in the main channel of the River St. Lawrence, the commissioners request the same be given them for this purpose at as early a date as possible.

We have the honor to be, sir, your obedient servants,

THOS. C. KREFER,
JOHN KENNEDY,
HENRY F. PERLEY,
PERCIVAL W. ST. GEORGE.

A. GOBBIL, Esq., Secretary Public Works, Ottawa.

Reference No. 75,275.

CHIEF ENGINEER'S OFFICE, OTTAWA, 16th March, 1887.

SIR,—With reference to the letter of 10th March from the members of the commission appointed to enquire into, and report on the floods at Montreal, asking authority to expend a sum not exceeding \$3,000 in breaking up the ice in the main channel of the St. Lawrence extending from above Longue Pointe towards Ile Ste. Thérèse, I have to state as follows:—

In November last, the commission suggested that an experiment be made to keep open during the winter the channel of the St. Lawrence above Three Rivers, by the use of tugs especially prepared for that purpose, and an Order in Council was passed on the 26th November, authorizing the sum of \$2,000 towards carrying out this experiment, and directing that a special warrant of His Excellency the Governor General be issued and the amount placed in the Supplementary Estimates for the current year.

Owing to the lateness of the season it was impossible to carry out these experiments, and the amount authorized was not required.

As it is probable that Montreal may be flooded again during the ensuing spring, the commission is desirous of opening up by means of explosives a portion of the channel below Boucherville, that having been found to be the point where the free flow of the river in the spring is most retarded.

The commission states that the cost of these explosives would be \$3,000, and as I am of the opinion that the experiment is worthy of trial I have to suggest that, as the amount required in connection with the tugs has not been expended, it be transferred and made available for the purpose of the explosions the commissioners are now desirous to try.

I am, sir, your obedient servant,

HENRY F. PERLEY, *Chief Engineer.*

A. GOBEL, Esq., Secretary Public Works Department.

Reference No. 76,020.

CERTIFIED COPY of a Report of a Committee of the Honorable the Privy Council, approved by His Excellency the Governor General in Council on the 7th April, 1887.

On a memorandum dated 4th April, 1887, from the Minister of Public Works, submitting that Parliament at its last Session voted the sum of \$5,000 towards the cost of an "Examination in connection with spring floods at Montreal and vicinity," and it was understood that the sum of \$10,000 was to be expended on account of such examination, and that the Corporation of Montreal would furnish one-half of the amount.

The Minister represents that an over expenditure has been incurred by the Government of \$2,184.60 in excess of the amount voted by Parliament, and that the Flood Commissioners now apply for a further credit of \$3,000.

The Minister recommends, as the necessity is urgent, and the Minister of Finance having reported there is no appropriation from which the same can be taken, that a special warrant of His Excellency the Governor General do issue for the sum of \$2,815.40, which, added to the vote of \$5,000 and the over expenditure of \$2,184.60, will make the \$10,000 which it was decided to expend on the examination—the amount of the said over expenditure, and that of the warrant hereinbefore mentioned, in all \$5,000, to be recouped to the Government by the payment on the part of the Corporation of Montreal of the promised contribution.

The Committee advise that a special warrant do issue as recommended.

JOHN J. MCGEE, *Clerk Privy Council.*

Reference No. 76,343.

(Translation.)

The Honorable Sir HECTOR LANGEVIN, C.B., K.O.M.G., Ottawa.

SIR,—I have the honor to invite your attention again to the request of the Council of the Village of Laprairie concerning the improvements to be made to the harbor of this place and certain works of protection against the floods of the River St. Lawrence.

Immediately after the interview with which you were good enough to favor Messrs. Tassé, Charlebois and myself, on the 6th instant, I would have liked to have prepared this document and submitted it to you, but, since then, illness, and, indeed, death, having visited my family, I am compelled to explain the delay which has occurred, and to beg to be excused for it.

Having accomplished this duty, I hasten to enter into the heart of the subject which is engaging us.

The question of improvements to the harbor of Laprairie has been before you, sir, since the winter of 1882. During the years 1882, 1883 and 1884, works of some importance were accomplished, especially at the quay and in its neighborhood. Everytime that I have had an opportunity of so doing, I have plainly expressed my gratitude for all that the Government has done in the interest of the taxpayers of this district, and I am happy to renew this expression to-day. To complete the work on this side, nothing more remains but to raise that portion of the quay which is nearest to the shore to the same level as the rest, and to finish the channel which leads to the waterway of the river. Two communications addressed by myself to your Department, under date of the 16th of March and the 28th June, 1886, contain information upon the same subject.

During a certain period, Mr. Arnoldi seemed to think that the channel as it now exists is sufficiently wide. However, the force of the wind in Laprairie Bay, the extent of which you know, is sometimes such that the passenger boats are in danger of touching, and that, in fact, they have touched on the edges of this channel. When they are towing a barge the risk of it is by so much the more increased. Indeed, if I may be allowed to employ an argument *ad hominem*, Mr. Arnoldi, while passing through this channel at the time of his visit in the month of June last, went aground himself and broke one of the wheels of his yacht. I think, however, that this gentleman did not need this accident to modify his first opinion, and that without it he would have decided to make a report in favor of undertaking the works asked for; but I think that the instancing of what happened to him is of a nature to produce upon the Honorable the Minister, under whose orders he is, a more effective impression, and that is why I signal him out.

In support of my case, I might again enumerate all the reasons mentioned in the original petition of the year 1882, asking for the opening of this channel, reasons which have preserved all their force, but I content myself with referring thereto. It will be sufficient for me to add that with the present channel there can be employed, for the transport of grain, wood, coal, etc., only barges of medium capacity, or to only half load them so as to make two trips instead of one. If this state of things is favorable for the navigation company which carries on the service here, it cannot be so for the trade in general. It was in this way, too, that you understood it, sir, by admitting the principle of the necessity of a new channel, and by ordering the commencement of the dredging works therefor. If it pleases you to put the crown to this work which is already well advanced, the public will have the full benefit of the expenditure made up to date by your Department on behalf of an improvement which has been claimed for a long time, and the utility of which nobody can contest.

In the course of our last interview you pointed out to us that the ordinary credits for the improvements of harbors and rivers having not yet been voted by Parliament, it would be difficult for you in any event to do anything before the 30th of June next. Would it not at least be possible to have the dredge come here at the opening of navigation? For, when once the month of May is over, it is impossible to tow it above the Victoria Bridge. I especially invite your attention to this latter point.

The continuance of the works of protection against the river floods is equally of the highest importance for the Village of Laprairie. This question is one of painful reality for many families which at this moment are casting anxious looks towards the Dominion Government and are expecting from it their safety. It is the imperative duty of the municipal authorities to urge our rulers with earnest requests in order to obtain prompt help from them, and to work so as to prevent as far as may be in their power the recurrence of the disasters which signalized the floods of 1885 and 1886. I had the honor, in two letters dated respectively the 6th October, and the 25th November, 1886, to submit, for your consideration, a very simple and inexpensive plan of protection, which met with—I am confident of that—the approval of the engineers of your department. The cost of it is estimated at \$5,000, according to Mr. Perley's report. The first thing which strikes one, is that

such a sum seems very little, seeing that it is intended, for the completion of dyking works of a nature to protect a village of such importance as ours. It would not be so without the proportion offered by the municipality in the shape of work already done and the value of which certainly surpasses by half the total sum asked from your Government.

In order to conform with the recommendation contained in the report above cited, the corporation of Laprairie has ensured for itself the possession of the old "Champlain and St. Lawrence" embankment, as well as of all the land necessary elsewhere. As was agreed upon during the interview of the 6th instant, the corporation undertakes to replace the stone pavement which exists in some places in the projected embankment, and to do so in a manner satisfactory to those concerned. After having studied the question well, I cannot arrive at a better suggestion than that of causing to be deposited on the quay the earth taken out of the river by the dredge, in order to cover with it the streets which are intended to form part of the dyke. Without being able to determine exactly the geological composition of the bed of the St. Lawrence in Laprairie Bay, I can affirm, being supported therein by experience, that no heavier, more solid, and more durable soil could be employed for the purposes desired. Evidently, it is not possible to find in place, in the heart of the village where all the houses are, the necessary materials for raising the streets. As soon, then, as it is necessary to go to some distance, the harbor is as near at hand as any other place at our disposal. On the other hand the use of such advantageous soil in preference to arable soil without consistence, would compensate and even more than compensate the increased expense incurred to obtain it. We shall have a permanent work which it will not be necessary to repair or to commence over again the following year. In fact, the recommendation to no longer obstruct the river, which has been made by so many competent engineers will be accomplished by the same means.

Casting a glance of the eye over this epistle, which is so long that it would be difficult to read it all at one time, I am afraid, sir, that I have abused your patience. The desire to render a service to my fellow citizens of which they are absolutely in need, is my only excuse. If, on the most evil day of its history, Laprairie finds a powerful and enlightened protector in you, no one will have a right to be astonished at it, for the goodness of your heart is known and appreciated by the people of this village, for whom it has been shown more than once already.

In the hope that it will not contradict itself in this decisive case, I have the honour to sign myself, sir,

Your very humble and obedient servant,

T. A. BRISSON, *Mayor of Laprairie.*

LAPRAIRIE, 20th April, 1887.

Reference No. 76,582.

CITY CLERK'S OFFICE, CITY HALL, MONTREAL, 30th April, 1887.

SIR,—I have the honor to transmit to you herewith an extract from the minutes of a meeting of the Finance Committee, held on the 28th instant, relative to the question of the floods at Montreal.

I have the honor to be, sir, your most obedient servant,

CHAS. GLACKMEYER, *City Clerk.*

A. GÓBEL, Esq., Secretary Department of Public Works, Ottawa.

EXTRACT from the Minutes of a meeting of the Finance Committee, held on the 28th April, 1887.

Submitted and read a letter from the secretary to the Department of Public Works at Ottawa, of date the 14th April, instant, calling upon the Corporation to pay their share of contribution towards the costs incurred by the Flood Commission.

Resolved, That whilst they are prepared to pay their contribution towards the costs of the Commission, as agreed upon, this committee, in the meantime, would like to know if the Commissioners, who were appointed, have any practical and effectual measures to offer, to prevent the inundations to which the city is periodically exposed, and how soon their report to that effect may be expected.

Ordered, That a copy of the foregoing resolution be transmitted to the Secretary of the Department of Public Works at Ottawa.

Certified.

CHAS. GLACKMEYER, *City Clerk.*

Reference No. 77,222.

CHIEF ENGINEER'S OFFICE, OTTAWA, 18th May, 1887.

SIR,—The Mayor of Laprairie calls attention in No. 76,343 to previous applications made for harbor improvements at that place. These are well known to the Department, and the Minister has directed that a dredge be placed at Laprairie immediately for the purpose of removing the obstructing portion of bottom lying between the two channels at that place.

The Mayor also refers to the work that has been done for the protection of their village against inundations, and states that the continuation of the works is a matter of the highest importance to the residents of the village.

Under date 14th of December last, I reported on an application of the municipal council of Laprairie, that steps be taken to prevent the periodical flooding of their village, and submitted a scheme for the prevention of the same, estimating the cost at \$5,000.

This scheme might be modified by the construction of that portion of the work shown on the plan accompanying No. 73,223 from the southern end of St. Ignace Street across the brook used as the main drain of the village and thence eastwardly along the old embankment of the disused railway which it appears has become the property of the village corporation. This embankment, with a sluice in the brook, would cost about \$1,250.

During the past year two ice breakwaters were constructed near the southern end of St. Ignace Street which were tested to their fullest capacity during the extreme high floods of the past spring, and the inhabitants of Laprairie agree in stating, that without these piers great destruction would have been done to their property—a large *banquise de glace* struck the small pier breaking the ice in pieces as it reached the top, without, however, stopping the current from carrying the *banquise* downwards, but when it got to the large pier it was stopped, and thus the village was saved.

I am, sir, your obedient servant,
HENRY F. PERLEY, *Chief Engineer.*

A. GOBELL, Secretary Public Works Department.

Reference No. 77,379.

CITY CLERK'S OFFICE, CITY HALL, MONTREAL, 21st May, 1887.

SIR,—I have the honor, by direction of His Worship the Mayor, to transmit to you herewith a memorandum of facts or points in connection with the recent interview at Ottawa between you and the delegates from this city on the subject of inundations.

I have the honor to be, sir, your obedient servant,
CHAS. GLACKMEYER, *City Clerk.*

Sir HECTOR LANGEVIN, Minister of Public Works, Ottawa.

MEMORANDUM of points submitted by the flood delegation from Montreal to the Honorable the Minister of Public Works.

The delegation was composed of :

1st. Delegates from the City Council and Montreal Board of Trade.

2nd. Delegates from the Committee of citizens.

3rd. Delegates from the Harbor Commissioners.

The substance of the representations made to the Honorable the Minister were as follows :—

That the annual flood at the City of Montreal, produced by the overflow of the River St. Lawrence, always productive of serious damage to the city and adjoining counties, had of late, and particularly during the last two years, reached a height unprecedented in the history of the city, had caused incalculable injury to a considerable portion of the city and to its trade and railway communications, and inflicted much misery and hardship upon its inhabitants. That public opinion has been now thoroughly aroused in respect of this question ; and that the welfare and progress of the city and of the adjoining counties, and their inhabitants, imperatively demand immediate protection from the recurrence of these disastrous floods.

That the City Council and the citizens are satisfied that the recommendations of the Commission of Engineers appointed to consider the subject in so far as they relate to the protection of the city, are in the main judicious, and that they should be carried out.

These suggestions consist in substance of the following :—

1. That a permanent dyke should be erected round the portion of the city lying south-west of the Lachine Canal, of a sufficient height to protect it from the incursions of the river.

2. That a sufficient temporary dyke should be erected along the front of the city lying north-west of the canal.

3. That a permanent dyke should be erected for the effectual and permanent protection of the last mentioned portion of the city.

In addition to these representations of the Commission of Engineers, it is the conviction of the City Council and of a great majority of the citizens, and probably cannot be effectually disputed ; that the flood is caused by the accumulation of ice below the city, which ice descends from the upper reaches of the river during the late autumn and early spring. The ice thus descending is intercepted by that formed in the calm water below the city, and gradually accumulates, raising the water during the winter to a very considerable height. And in the spring the additions made to it by the lower portions of the lake ice produce a barrier or dam, which throws back the water upon the city.

That elsewhere, experience has shown that under similar circumstances the detention of the ice in the upper reaches of a river, until the channel below them is clear, has been successful in preventing or mitigating floods ; and that such a result might be obtained in the St. Lawrence by placing piers or booms at the foot of Lake St. Louis to retain the ice there until the channel below becomes clear. And it is believed that by this means, the counties adjoining Montreal, as well as the city itself, would be protected.

That from the foregoing statement of the works to be done, it is obvious that they are of a very extensive character, and that they affect different interests which should in a due degree combine to obtain protection, and it was submitted to the Honorable Minister that these different interests and their respective obligations with regard to protection, might be roughly outlined as follows :—

The city to undertake immediately the construction of the dyke round the Point St. Charles section, and the construction of the temporary dyke along the front of the city.

The city, with the co-operation of the Harbor Commissioners, and the assistance of the Government, to proceed with the erection of a permanent dyke along the front of the city, acting of course upon professional advice as to the mode of construction of such dykes.

In speaking of the co-operation of the Harbor Commissioners, it was not suggested that they should undertake substantially the performance of or make any contribution to the construction of this dyke, but as it would probably be so constructed as to form the boundary between the territorial jurisdictions of the city and the Harbor Commissioners, it must necessarily affect them more or less. For instance, it is possible that it might be found that some part, or the whole, of the revetment wall would need rebuilding, and possibly that the line on which it is built might require to be changed in some degree, and it is also probable that the revetment wall might form to some extent the foundation of the dyke, and might indeed be an integral part of it, if the wharves should remain at their present level, or should not be raised as high as Commissioner Street.

In such a case, it is plain that the Harbor Commissioners and the city, would, from the very nature of their rights and interests, be obliged to co-operate in the work, and it is in this sense that the Harbor Commissioners were referred to in the representations made to the Honorable Minister. But at present, in consequence of the heavy charges on the harbor and shipping, caused by the necessity for the payment out of those charges of the interest on the Lake St. Peter debt, it is impossible for the Harbor Commissioners to undertake any new work for the benefit of the harbor or for its extension.

That in undertaking the construction of such large and extensive works as the above, the city would hope for the assistance both direct and indirect, of the Government.

That in other places subject to similar recurring calamities, Governments in other countries had afforded such assistance.

That in the cities of Antwerp and Hamburg, where works of protection had been executed, the General Government and the local authorities, had contributed directly along with those cities, to the construction of the works required; and the levees and dykes for the protection of the city of New Orleans were constructed and maintained at the expense of the state.

That there are several special reasons for the interposition of the Government, among which were mentioned the following, namely:—

The fact that it is probable that the floods have been aggravated by the deposit in the shallow waters below the city, of the dredgings from the harbor works; and this probability is strengthened by the fact that such dredgings have been stopped upon complaints of such a result.

That the River St. Lawrence is a navigable river under the jurisdiction and control of the Federal Government, and that important works to keep its waters within their natural channel, should be federal works.

That the Federal Government own very large properties in the city of Montreal, which receive their protection from disasters, fires and other casualties at the expense of the city, and have the benefit of the city administration, but are wholly exempt from taxation; and that in the event of an extraordinary expenditure outside the ordinary administration of the city, being required for the general benefit, it would seem reasonable that the Government should contribute with other proprietors.

It was therefore suggested that the Government might assist directly in the construction of the works of protection, by contributing a sum of money which might represent the capital of what the Government as a proprietor in the city would be bound to contribute annually were it not for the exceptional law as to exemption.

That it might undertake this season the construction of some work by means of piers and booms, or otherwise, to detain the ice formed in the upper reaches of the river, until the lower channel should become clear.

That it would probably, as a matter of course, raise such portions of the banks of the canal as might be necessary in conjunction with the dykes, to exclude the entrance to the water by means of the canal, upon either side of it.

With reference to the Harbor Commissioners and the Lake St. Peter debt, strong representations were made by the delegates in favor of the assumption of the

debt by the Government. Many of the delegates pressed this assumption strongly, as well on public grounds, applicable to the whole Dominion, as on the ground that such assumption would strengthen the hands of the Harbor Commissioners in the performance of such work as might properly fall to their share in the course of operations for the protection of the city. And they referred to the arguments that had already been used by the delegation and by the press, without reference to the floods; resting upon the character of the work as being a Federal work, as much as one of the Federal canals, and enlarged upon the injustice of leaving the interest upon its cost a special charge upon the harbor and shipping of Montreal. And it was the unanimous opinion of the delegation that now was a fitting time to urge the assumption of this debt upon the Government, not only upon general grounds applicable to that proposition, but also for the reason that doing so, would enable the Harbor Commissioners to do what might be proved to be incumbent upon them in connection with the new works on the line of the harbor now urgently needed. Several of the speakers endeavored to make it clear that the representation of the delegation did not mean that the Harbor Commissioners should use the revenue which would be free by the Government's assumption of the debt in any work for the protection of the city, but merely that some expenditure would be necessary where any part of such work proved to be of such a character as naturally and necessarily to be constructed by the Harbor Commissioners.

The representations of the delegation might tersely be summed up as follows:—

1st. That the Government, as proprietor of property, should make a reasonable contribution to the cost of the permanent dykes.

2nd. That the Government should cause means to be taken to retain the ice in the upper reaches of the river, and should raise the banks of the Lachine Canal wherever necessary.

3rd. That the Government should assume the Lake St. Peter debt.

The whole respectfully submitted.

J. J. C. ABBOTT,

Mayor.

GEO. A. DRUMMOND,

President Montreal Board of Trade.

MONTREAL, 21st May, 1887.

Reference No. 77,829.

STATEMENT of Expenditure incurred by the Government, from 1st July, 1886, to 8th June, 1887, for Surveys and Experiments in connection with the Montreal Spring Floods, showing names of persons to whom payments were made and dates of such payments.

Date.		Amount.
		\$ cts.
1886.		
July 2	T. O. Keefer, Chairman of Commission, on account of disbursements	1,000 00
August 10	do do do	2,000 00
October 6	E. D. Lafleur, services as Engineer and travel and expenditure	184 90
November 19	T. O. Keefer, Chairman of Commission, on account of disbursements	3,000 00
1887.		
March 22	T. O. Keefer, Chairman of Commission, on account of disbursements	2,000 00
April 9	do do do	1,000 00
do 13	do do do	2,800 00
Total		\$ 12,984 00