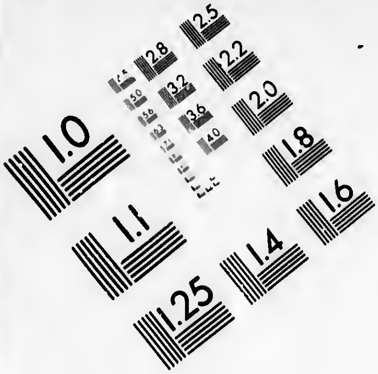

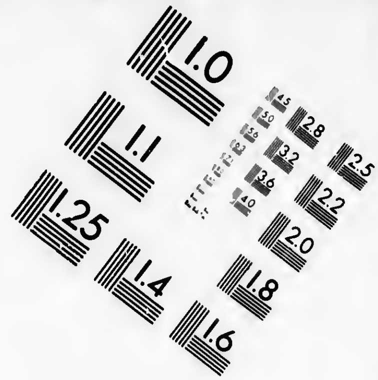

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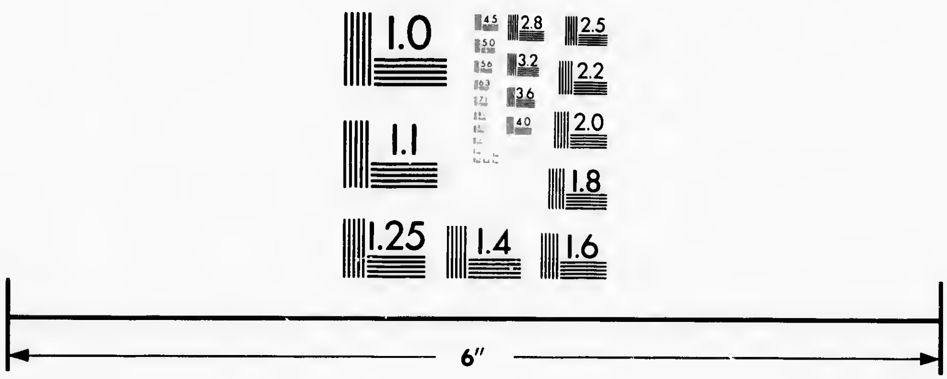

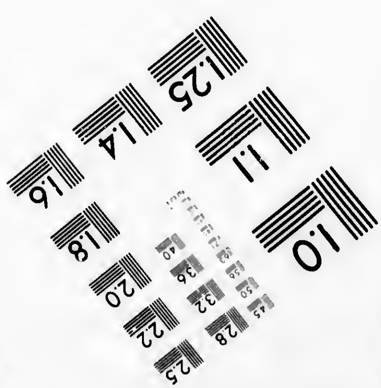

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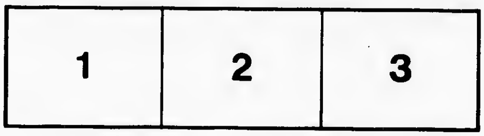

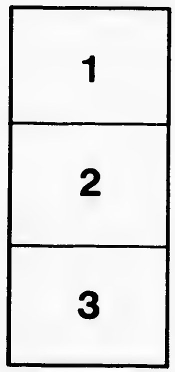

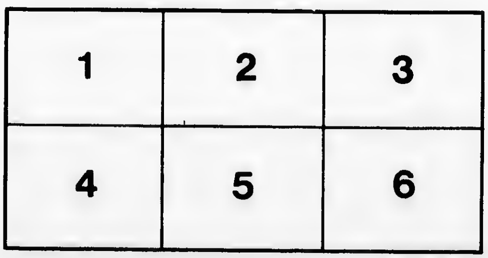

REPORT

ON

WATER SUPPLY

FOR THE

CITY OF OTTAWA,

BY

THOS. C. KEEFER, C.E.

OTTAWA:
PRINTED BY BELL & WOODBURN, ELGIN STREET,
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REPORT.

OTTAWA, May 13th, 1869.

W. P. LETT, ESQ.,
City Clerk, Ottawa.

SIR,—

The Surveys and Estimates necessary for determining the cost of a Water Supply for the City of Ottawa being completed, I beg to submit my Report thereon with the Plan shewing the extent of Pipage proposed, and the different sites for Pumping Machinery.

There is no other mode of supply except by pumping, and for a City like Ottawa, with districts of such unequal elevation, a pumping system presents advantages over any other. In Quebec, where the supply is by gravitation, and the fountain head several miles distant, and more than one hundred feet higher than the highest point in the City, it has not been found practicable to keep any water constantly upon the higher levels, in consequence of the draught from the lower districts—and the greater the head the greater the difficulty—the discharge from very small apertures in the low districts, under such great pressure, being sufficient to take all the water away from the high level pipes. The only remedy for this would be high level reservoirs within the City, or duplicate mains separating the high from the low districts.

In gravitation plans it is necessary either to provide a supply for future generations, entailing heavy interest charges on the present one, or else to duplicate the works at great extra cost when an additional quantity is required—and in this respect pumping systems have generally the advantage over others, additional pumps being added only as required, and at a comparatively trifling cost.

Gravitation supplies must also be assumed for a fixed level, and with the increase of consumption and waste, an annually increasing loss of head sets in for which there is no remedy save a higher head, which the fixed level cannot supply ; but with the pumping system, the water can be kept up to any required level by the application of more power.

My instructions require me to keep the estimate if possible within $300,000, and direct my attention to what is known as the "Holly System," which is exclusively a pumping one, and conspicuous for its economy.

An impression prevails that, from the experience of other cities, a very large sum will be required. In Montreal, Quebec and Hamilton it was necessary to go from six to eight miles from the centres of the City to obtain a desirable quality of water, whereas in Ottawa this is found within the City, and within a mile of its centre. At Montreal it was necessary to expend far more than the whole required cost here to reach the point where the Ottawa Works begin ; and after the water power was thus created, the machinery was still two-and-a-half miles from the City's centre. At Hamilton it was further necessary to construct works for filtering the water before it could be used.

In the important question of the quality of the water, Ottawa is equally fortunate. The water from a river of such volume, taken under the most favorable circumstances for maintaining its purity, is unsurpassed in quality by that of any river of equal dimensions. It is softer, and therefore better than the St. Lawrence water, although from the difference in color this is not the popular belief. The brown color of the Ottawa is a vegetable tinge, while the clear water of the St. Lawrence, like that of the sea, and of wells generally, is impregnated with mineral salts. The Ottawa drains a primitive formation generally, from which the rain is thrown into the river tinged only by the color extracted in the swamps. The St. Lawrence is supplied from a more alluvial district from which the rains have washed out the salts into the great lakes. Both qualities and causes are seen here ; the Rideau water being quite hard, and that of the Ottawa preferred for all domestic purposes.

This comparative softness of water becomes quite an important item as an economical question, when applied to the whole consumption of the City. In the two articles of tea and soap, so universally used, the two qualities can be measured by a money value, representing thousands annually in the consumption of large cities ; while for manufacturing purposes, dyeing, tanning, brewing, &c., a soft water is invaluable.

A more important question, however, than the mode of supply is the principle on which it is carried out—whether high or low pressure; in other words, whether first or second class—and this is governed by circumstances.

If Ottawa were situated upon a lake, with neither water power nor gravitation supply near at hand, steam power would be requisite; and as the annual cost would be in proportion to the lift, no greater height of delivery than that required for domestic purposes would probably be attempted; or, if a gravitation supply only sufficient for the highest buildings were within reach, nothing more would probably be sought for. Thus in the oldest and most important water works on the Continent, viz., at Philadelphia, New York and Boston, the low pressure systems exist. At Philadelphia, which has the pumping system with water power, the lift at Fairmount is about 90 feet—that being the elevation of the nearest reservoir site, and at the same time sufficient to supply the houses.

In New York and Boston, notwithstanding expensive City reservoirs, the supply, though abundant, is often restricted to the first floors of the houses, in consequence of the great draught. For fire purposes the only value of their water works is to feed promptly the fire engines; and, for this purpose alone, hydrants were so much superior to wells, tanks or water carts, that a great advance was made.

It does not appear that the question of dispensing with fire engines altogether was considered in connection with the construction of water works until within the last twenty-five years. The pressure required for this purpose was, until recently, looked upon as inconvenient, and to a certain extent hazardous; but house-taps have been improved, and it has been settled that the cost of the street pipes is scarcely affected by it, because the smaller sized pipes, which form the bulk of the distribution, are necessarily made stronger (in order to insure good castings) than is required for any water pressure. Furthermore, it has been proved that, although there may be an abundant supply of water, fire engines even when worked by steam, are not always reliable in very cold weather,—when, if meeting with any temporary derangement, they are quickly frozen up and become useless.

For the speedy extinction of fires, nothing can equal the high pressure hydrants, from which, as soon as a hose can be attached, a ceaseless stream is poured on the flames, confining them to the place of origin. This system not only extinguishes the fire in the shortest possible time, but it has been found greatly to reduce the number of fires, and has been the means of detecting incendiarism. The fire is extinguished before the proofs of intended incendiarism are destroyed, and the prepared and saturated combustibles are thus revealed. (See Appendix.)

Great as are the advantages of an abundant supply of water for house and street purposes, undoubtedly the most important consideration is the extent to which protection from fire can be relied on, for this involves not only the preservation from absolute annihilation of property many times more costly than the works themselves—but, on their relative efficiency in this respect alone their success in a financial point of view may be established. In Montreal—which at one fire lost more than her Water Works have cost—the high pressure system has reduced the rates of Insurance by an amount equal to the interest on the cost of the works—and with an equally efficient system the same result might be expected here.

It is only in the case of pumping by steam power, or extensive artificial water power, that the high pressure system entails any important extra expense. In the Holly Works, when the water power is already made, it is attained at a less cost than usual by the application of more power only, and without the cost of reservoirs.

The Holly system is generally understood as the "no reservoir, high pressure" system, but in neither of these respects is it peculiar, because there are many works without reservoirs, and others with high pressure. Chicago, situated on a low prairie, cannot have reservoirs. Quebec, from a natural head, has double the pressure of the Holly Works.

The peculiarity of this system consists in the employment of rotary pumps, which possess the power of rapidly increasing the pressure, and thus supplying the place of high level reservoirs, when none such are possible, either from physical or financial reasons.

There are other works without reservoirs, where, as in the Holly plan, the water is pumped directly into the distributing pipes, and fire pressure given, and where also the speed of the pumps varies with the consumption, (though not to the same extent as is practicable with the rotary pump)—but the principle of the Holly system is, that it is designed to give a fire pressure on demand, at any point of the distribution, by the aid of the machinery alone. The same result may be obtained under any other pumping system, without reservoirs or rotary pumps, by increasing the size, or speed, or number of the ordinary pumps ; and by assuming the risk which always accompanies the absence of a reservoir.

Reservoirs which form an important and valuable feature of most Water Works, do not depend on the money question alone. They are not always possible, and their value when possible is governed altogether by local considerations. For fire pressure they are of no value unless they can be had at a sufficient elevation, and this depends on physical features entirely. In New York, Boston and Philadelphia there are no elevated sites for such reservoirs; but at Montreal and Hamilton, a mountain immediately behind each city affords the opportunity. At Ottawa there is no site for a reservoir sufficiently elevated to give a fire pressure over the more important parts of the city, and reservoirs here could only serve as a protection in case of stoppage of the pumps or accident to a pipe. Such reservoirs must be detached from the pipes if the high pressure is to be maintained; and it is with reference to this that a system without a reservoir, like the Holly, may be superior for fire purposes to one with a low level reservoir, which prevents the accumulation of a fire pressure in the pipes.

While on this subject, I may say that reservoirs are not always expensive affairs. In side, long, and rocky excavations, when of large dimension, or when land is costly, they may be very expensive ; but there are cases where they serve a very valuable purpose, and when the cost has been trifling. In a system of closed pipes required to maintain the fire pressure, the pumps cannot be stopped for an hour, and an accident to the pumping main would for the time, be a break down of the whole system. This risk may be almost entirely removed by a duplication of the pumping main, as well as of the pumping machinery. But if in the absence of these, a reservoir, however small, could be obtained at an elevation only sufficient to keep the pipes full, it would amply repay its cost, which need not add more than two or three per cent. to the estimate.

THE HOLLY SYSTEM

Derives its popularity from its economy and efficiency. Its economy is due to its being a pumping system, in which the cheapest description of machinery is employed; and its efficiency consists in its rendering fire engines unnecessary;—and as it is almost the only system in the United States which does this, there is no doubt that to this latter feature chiefly is to be ascribed its great popularity, as well as to the fact that it has been favorably contrasted on the score of economy with certain American pumping syst ms, where large and expensive reservoirs are used to provide storage for months. At Jersey City, for instance, a single pumping engine is used in connection with a large reservoir, designed to maintain the supply in case of damage or repairs to the machinery. Instead of single sets of machinery and large reservoirs, the Canadian pumping system is (like Holly's) duplicate sets, with the addition of small reservoirs to meet any short interruption to the supply from the pumps. In the American system the water is usually pumped into the reservoir, and thence becomes a gravitation supply—but in the Canadian it is pumped directly into the distribution, as in Holly's plan,—the reservoirs being merely side pockets to take the surplus when the pumps send more, or supply the deficiency when they send less than the city requires. This variable demand is met in the Holly plan by a pressure-gauge and self-acting governor, by which the speed of the pumps is increased or diminished; and in case of fire an alarm is rung and an extra pump brought into play. If the reservoir were shut off at Montreal, and the telegraph were used to start another wheel when a fire occurred, it would be the Holly system in effect, although with different machinery.

The rotary pump was first applied by Mr. Holly, a few years ago, to the supply of towns with water. Other makers of rotary pumps which are claimed to be equal and superior to the Holly pattern, do not recommend them for constant work, and I find that Mr. Holly does not do so in all cases. Rotary pumps are small, and hence their cheapness, as well as the practicability of making them comparatively tight. To deliver a large supply, they must either be run at full speed, or enlarged so as to be able to deliver the same quantity with a slower motion. In the first case, under the high lift necessary at Ottawa, the bearings must wear down rapidly; and in the second, the relative economy disappears, and the difficulties of perfect construction increase. On visiting his works at Lockport, a few days since, I found that Mr. Holly was preparing a "gang piston pump," for domestic service at Auburn, where the rotary has been longest in use; and it will be seen from the letter of the Holly Company annexed to this Report, that they recommend a similar pump for Ottawa, with two rotaries as fire pumps only. Under these circumstances it is not necessary to discuss further the well-known objections to rotary pumps for constant use. The question to be decided is, whether there should be a mixture of systems, or whether, a reciprocating pump being necessary for the constant supply, a duplicate of the same would not be the proper system.

As a matter of economy, whether it be from the greater cost of the gang pump, or the higher value of labor and materials at Lockport, the valuation set by the Holly Company on the pumping machinery proposed in their letter, is in excess of what is needed to provide duplicate sets of the ordinary, and as I think, more reliable machinery.

With rotary pumps three sets will be necessary; with the other, two would answer the same purpose; and although the former would probably cost less in first outlay, I do not think there would be sufficient difference to prevent the selection of the better system.

The principal objection to the rotary pump is that as it would be necessary in the first instance to import them from some maker of established reputation, so, for repairs, (which they are more liable to require than other pumps,) it is found necessary to send them back to the maker, and from the delay which this would involve an extra set is needed. Moreover, as they are not adapted for constant service here, they could not take the place of the piston pumps for this purpose. The latter, therefore, would have no duplicate, and yet it would be important that, in a system without reservoirs, the domestic machinery should be in duplicate as well as the fire pumps. With two similar sets fit for domestic or fire service, the duplicate would be ready for constant work whenever the consumption outgrew the capacity of the first.

Mr. Holly's Hydrostatic Pressure Regulator is a most valuable attachment to any pumping machinery, working directly into the distribution, and such a regulator would be indispensable here, where to secure the fire pressure we must adopt the Holly system, although we may not have the remainder of the Holly machinery.

Mr. Holly, by his ingenious and economical arrangement has done invaluable service to many towns, and by his rendering all kinds of fire engines unnecessary, will doubtless create a revolution in the existing system of Water Works throughout the United States.

WATER POWER.

A Water Power may be created at almost any point between Pooley's Bridge and the Slide Channel, by bringing down a Canal from the Bay above; and, as far as the power is concerned, (since there would be the same head and fall,) all sites would be equally efficient. But, in bringing down any artificial channel through the Chaudiere Flats, except possibly one by Oregon Street, it would be necessary to go to the additional expense of a pure water conduit for the supply to the pumps, because the canal would receive impurities from both sides to an objectionable extent.

It will probably be found as economical to purchase a right of way through private property for this canal, as to make use of any of the streets. The necessary interference with the street, during construction, would give rise to claims for damages from both sides: and the cost of covering, and maintaining this covering so as to restore the street to usefulness, may, together, make the street the more expensive route. To avoid a repetition of such expenditure, and because there would be no means of enlarging in the future without interrupting the supply, it would be necessary to give the channel capacity enough for all time; and as this would occupy the greater part of the roadway, it would be better to purchase out the proprietors, and re-sell after the completion of the works.

This course would, while requiring a larger immediate outlay, be attended with less loss in the end. But, looking to the interference which such a canal must necessarily make with all the purposes of gas, water and drainage, for which streets are required, I think a street route inadmissable.

GULLY ROUTE.

The gully which is crossed by Pooley's Bridge is connected at its head with a depression in the Flats, extending to the Bay above, through which in full flood time the Ottawa makes a high water channel. This is one of the proposed routes, and in proportion to its length a favorable one; for it would require less excavation than the shorter, though higher route through Queen Street. A reserve of sufficient width, unoccupied by buildings, is in the hands of two or three proprietors, for water-power purposes, and it is understood they will offer the City every facility for obtaining the necessary power here. In this case the wheel-house and pumps would be on the East side of the gully, immediately above Pooley's Bridge, which would be the best possible position for them. The pumping main would be as short as possible, and it would not be necessary to carry it across the gully, as must be done with any more Western site. As this route involves a canal nearly half a mile in length, the necessity for ample dimensions, because of the impracticability of future enlargement, is obvious; and for a canal of this length, through rock excavation, a considerable sum is required. If this canal were connected with the slide channel, along the route of Britannia Terrace, it would be practicable to keep up the supply to wheels and pumps at Pooley's Bridge while any future enlargement of the channel was in progress. But without some such provision it would be necessary that the full dimensions be excavated at once.

I understand it is the desire of the owners of this route to open it at once on a large scale for general purposes, and to guarantee the City ample power for a specific sum; and as the same parties control the land between Pooley's Bridge and the Slide Channel, they ought to be in a position (with the consent of the Crown,) to secure the City an unfailing power at all times.

In any arrangement by which the City become Lessees, or Partners as it were, in a water power, entire independence must be secured. Having no storage of water to fall back upon, the certainty of an unfailing pumping power, not only from day to day, but from hour to hour, must be assured.

This channel being in rock, and through valuable land, it will be better to secure the required sectional area, by increasing the depth rather than the width. The depth can be increased without increasing the top width, as in earth sections, and at about the same cost per cubic yard, for there is natural drainage by the Gully.

ICE.

In sounding the Bay at low water in the end of March, I found that from the superincumbent weight of snow, the ice was pressed down into the water to a depth of from two to two-and-a-half feet. This was in the open Bay, where the snow would be blown off to a great extent. In an inland canal, with water level below the ground surface, the depth would be increased by drifting, and the ice still further encroach on the waterway, and a depression even of three feet may occur.

Taking two canals of the same sectional area of 200 square feet, the one 20 feet wide by 10 feet deep, the other 40 feet wide by 5 feet deep, the former would have, with three feet of submerged ice, an available waterway of 140 square feet, with 60 square feet of ice on top; the latter only 80 square feet of water, with 120 square feet of ice on top. This shows the advantage of the narrower and deeper channels over the broader and shallower ones, in this climate, for the same area. In point of fact, however, while the proportionate area is as above, the effective obstruction by ice should not be so great. Ice converts an open canal into a closed conduit, where the friction of the ice is a minimum, and the discharge is that due to the full head, ice included. This question of ice obstruction is a vital one in connection with water-power, for water-supply pumping purposes. Mills and factories may be arrested by it for a day or two, (in only occasional years), without much inconvenience; but this cannot be afforded with water works possessing no storage reservoirs. Great additional importance is given to this question by what has recently occurred at Montreal. For the last two winters an Aqueduct 40 feet wide on water line, with 8 feet depth of water, and nearly 5 miles long, has become almost wholly closed with ice before the winter was over. The process was gradual, accelerating as the water lowered; the obstructions increasing until, some time in February or March, the wheels were stopped for want of water. While this took place in the winters of '68 & '69, it did not occur at all in the winter of '67, although that was probably as cold a winter as 1869, but with less snow. In each of these three winters the Aqueduct entrance was left open to the river, and the condition of the machinery was the same. No attempt was made to prevent ice obstruction in either of these years, so that the difference in effect can be positively traced to one cause only, viz., the difference in the level of the River St. Lawrence,—in other words, to the depth of the water in the Aqueduct—which in 1867 was an average of two feet higher than during the last two winters. Whatever inferences may be drawn from the experience of Montreal, or whatever the amount of ice obstruction, which may be assigned either to climate or to local causes there, it has been established, in the most satisfactory and conclusive manner, that these can be met in the existing channel by a certain rise of water. It is hardly necessary with the experience of the last thirty years at the Rideau Falls and elsewhere in this neighborhood, to prove to the citizens of Ottawa that water power can be maintained without interruption in this climate in Winter. But as Montreal has, with the water power of the St. Lawrence at her back, erected a steam engine for Winter work, in a city where fuel is most expensive, it is proper I should notice the exceptional causes which have led to this step, in order to show that whether necessary or not at Montreal, there are no similar circumstances here likely to lead to the same result.

It may be premised that the difficulties at Montreal are wholly connected with ice in the Aqueduct. The pumping machinery and all other works have never failed to meet any demands made upon them.

From the foot of Lake St. Louis at Lachine, to the head of the Laprairie Basin, which is just below the Lachine Rapids, the River St. Lawrence is open throughout the year, and in very cold weather this open water is below the freezing point, and only prevented from congealing by its motion. Under this open water a granular formation of ice takes place on the bottom of the river, which is the effect of rapid radiation,—the cold rapid surface-current acting on the bottom like a cold wind on the human body. The process is analagous to the formation of hoar-frost by night-radiation from a warm soil into a colder atmosphere, and in both cases is arrested by any covering. Thus this formation (known as Anchor Ice) never takes place where the surface is frozen over, nor under the arches of bridges, &c., in open water. During the continuance of the extreme cold, this growth of icy moss, at the bottom of the river goes rapidly on, increasing in intensity just in proportion to the degree and duration of cold, until—at a season when all land streams are reduced by frost to a minimum discharge, and when the river volume is known to be less than at any other period, and to be daily diminishing—a sudden rise of the surface, more rapid than could be produced by any freshet, takes place.

Not a particle of ice is to be seen on the green surface of the moving water—but the bottom having been raised as effectually, for the time being, by this effort of Jack Frost, as if so many million yards of rock had been strewn over it—the surface *must* rise.

In January, 1857, after three days of the thermometer 20° below zero, the river rose in a few hours four feet, pouring down the Aqueduct before the gates could be closed, overflowing the flumes and flooding out the Wheel-house.

These severe cold "terms" are usually followed by a rapid rise of the thermometer, perhaps 60° or 70° in 12 or 24 hours; and when the temperature of the air gets about 40° Fahrenheit, the anchor ice, which may vary from a depth of a few inches to that of several feet, leaves the bottom and bursts up to the surfacein irregular "floes" and with considerable force, and floats down the stream. So long as the frost continues, the ice appears to be held at the bottom by its magnetic action, as is the tongue when brought in contact with frosted iron, and is detached in a similar way, that is by the proximate equalization of temperature between the earth and the air. This detached anchor ice, called "*frasil*" by the *habitants*, being nearly of the same specific gravity as water, floats chiefly below the surface, and is easily drawn by any current under the fixed surface ice. It is, therefore, the great enemy of water-power owners, stuffing up the racks of their mill races like so much wool, and often completely excluding the water. It is necessary, therefore, either to prevent its ingress by mechanical means, or to provide space enough for it, as well as for the required quantity of water.

From the foregoing it will be seen that the Montreal Aqueduct is exposed to two different kinds of ice obstruction. First, the fluctuations produced in the surface level of the St. Lawrence by the action of the *frasil* when forming on the bed of the river. Secondly, the *frasil* itself.

In the first case the sudden rise of water pours an Arctic current over the top of the Aqueduct ice, thickening and weighing it down lower than ever, as soon as the river again descends to its normal level. As this process may be repeated several times, and since the river is steadily falling in average level where not affected by this "flashing" of its rapids, reaching its lowest point in February or March,—in low water years like the last two, the water-way underneath the Aqueduct ice becomes reduced to a minimum. On the other hand the demand for water has from the growth of the City reached and passed the maximum scale of the works, and this attempt to draw the large quantity now required through such a diminished section, produces a current which tells decidedly on any *frasil* which may be stealing along the edge of the bordage or near the entrance to the Aqueduct, and it is then drawn in, steadily encroaching on the now limited water-way. As the *frasil* is not always forming it is not always floating; and, (as has already been shown) it has been found that without any precaution being taken at the entrance, but giving freest scope to both the fluctuations and the *frasil*, when the water section is as large as it was in 1867, the total winter accumulation of *frasil* combined with the effect of fluctuations on the fixed covering of the aqueduct did not prevent the passage of a power sufficient to pump the full supply ; while in '68 and '69, when the water-way reached its smallest dimensions, the combined effects of these two classes of ice obstruction, without entirely closing the water-way, stopped the wheels.

The causes which have proved so unfavorable at Montreal have had the reverse effect at the Chaudiere, the formation of ice-dams on the rocks having had the effect of giving generally a higher winter level of water than in midsummer. As to *frasil* I am informed that it has on some occasions given trouble to the Flour Mill near the Suspension Bridge.

There is no very extensive experience of the winter water-power, at the Chaudiere,—all the larger Saw Mills not being worked during the reign of ice ; but from the experience of the mills on the East side of the Slide channel, it does not appear that any *frasil* now enters here. As Nepean Bay is frozen over, none can form there ; and whatever may come down from the open water at the Little Chaudiere and "Remiques," would keep the line of the strong water outside. The whole condition of things at the Chaudiere has been so altered, however, by the improvements there, that no arguments can be drawn from past experience. When I was constructing the present Slides, in 1845, the Slide channel was nearly dry in September and March. No timber could pass after July or August, and Mr. McLachlin had been obliged to blast a ditch to get water to his Mill. From measurements made by Mr. MacDonald, Slide-master, in March last, when the Ottawa was as low as it probably ever will be, there was found a depth of 5 ft. 2. in. at a point where the depth in 1848 was only 1 ft. 11 in.

From what has been said, it will be seen that, with sufficient depth and area of water-way, no interruption to the water power by ice in any artificial canal need be feared; and it follows that the shorter the canal, the less the risk. In fact in a very short canal or flume, any such obstruction becomes removable if necessary. The best position for a water power therefore would be upon a dam with deep water above and below. There would be no outlay in this case for head or tail-race, and no obstruction to either from ice. The nearest approach to this at the Chaudiere would be by taking the power from the Slide Channel at the chasm near Victoria Foundry. Although it would lengthen the pumping main somewhat, the advantages offered by this position, are, First,—That it could be brought into operation in the shortest possible time, and at the least outlay in money. Second,—The water would be taken from points where it should always be in the best condition,—and no pure water conduit would be required as in the case of a thorough cut through the occupied portion of the Flats. Third,—In case of any future increase of the water power, by deepening the channel, the wheels could be supplied by a borrowed power from either side; and, lastly,—The water power here would participate to the fullest extent in any increase caused by raising the dams, or excavating the channel, which may hereafter be undertaken either in connection with the mills, or a canal.

For these reasons, and from the greater width of the natural channels, and their being connected together, a less depth of water here may be accepted than would be warranted in excavating a comparatively narrow cut through the flats.

Although I have estimated for the deepening of the channel here to the same bottom level for the purpose of a fair comparison, I think that, unless a favorable opportunity offered, this deepening might be postponed until experience proved it was necessary without much risk ; because one advantage of extending the pumping main to the Chaudiere Island would be that it might be connected with one or more of the powerful fire pumps there, to be used in cases of emergency. There are three Rotary Fire Pumps on this side the Falls. The new dam at the Chaudiere was only erected last Summer, and in consequence of it there has been no lack of water this Winter for those mills which felt a deficiency in previous years.

The past was not a severe Winter, but it was a very low water one ; and from the great depth of snow the surface ice no doubt encroached on the water-way more than usual. But on the other hand, a colder Winter might produce effects from *frasil* not yet experienced ; and, it must be remembered that the power required to supply the City will produce a decided increase in the Winter draught at this point. If, however, present wants can be met by the existing depth, the immediate outlay of a considerable sum may be postponed, and perhaps avoided altogether.

The site at the chasm on Victoria Island is the one involving the least outlay : but there is another very good, and in some respects better one (being more isolated), at the Government Reserve on the head of

Amelia Island. Another may be had on Victoria Island on the opposite side of the slide to this last, both discharging the tail-water into the slide channel at the foot of Amelia Island. Another site is at the head of the dry gully, in rear of Ahearn's Blacksmith Shop. This is upon private property,—the same owners as the Gully route. This last could be fed in three ways;—first, by a canal through Oregon Street, or through the vacant ground West of this street;—Second, by a cut taken from the slide channel at or immediately above the road bridge; and Thirdly, by bringing a flume around the stone mill, by the head of Amelia Island.

The best way to feed all these four sites, viz., the one at the chasm, the two at the head of the long slide, and the one behind the Blacksmith Shop, would be by bringing the head level down to Amelia Island, raising the long slide, and cancelling the Regulating Apron. This, as well as other features of these water powers, will be a matter of negotiation with the Dominion Government, as those of the Gully and other routes will be with individuals; and until all the conditions are known, no decision can be arrived at. When all the requirements of both parties are ascertained, a comparative estimate of costs and advantages can be made. In meantime enough is shown to determine the practicability within reasonable limits. All of the slide channel schemes can be carried out, with little difference of cost, without disturbing the present arrangement of the slides; and I know of nothing which is likely to cause any objections on the part of the Government to any of the plans. As to the Gully route, although I have estimated it, with the other thorough cuts, at the minimum width, for the purpose of fair comparison, I think that in view of the ice obstructions and the impracticability of future enlargement, these should be carried out on a much larger scale, proportionately, than the shorter and wider ones in the natural channels. But I take it for granted that the Gully route, when undertaken, will be on a scale sufficient to set at rest all these questions, because it is one of those schemes which would not pay upon a small scale.

FIRE ALARM TELEGRAPH.

I have already expressed the opinion that Water Works should be arranged with a view to the most rapid possible extinction of fires; and that it is with reference to this object they are to be chiefly valued. For this reason I consider the Fire Alarm Telegraph as much a part of the system as the Hydrants which are arranged for fire extinction. On the outbreak of a fire the value of minutes may be reckoned by thousands, and in the case of any valuable building, store or warehouse, the whole cost of the Fire Alarm may be saved by the Telegraph at a single fire. Moreover the expedition thus insured will not only save many a building, even when the contents are destroyed, or confine a fire to the single flat in which it originated, but it will soon pay for itself in the reduced expenses of the Fire Department. Half the number of men, and half the quantity of hose, the wear and tear of which is an important item, will do the work, if got out in the first five or ten minutes after the alarm. The Telegraph derives additional importance in connection with the Holly system. Mr. Holly depends on the Water Telegraph—the opening of a Hydrant reducing the pressure, which is immediately observed at the pumps, &c. But as Hydrants may be opened without a fire, or the pressure may be suddenly reduced by other causes, two signals are given, the Hydrant being opened and closed twice. The Fire Telegraph would prevent any mistake; the first warning from any signal box would be conveyed to the Wheel-house as soon as to the Hose Station and before a Hydrant could be opened; the full fire-pressure would be in force. The Water Telegraph can only be used by the Fire Brigade after it is called out, and only to convey a signal to the Wheel-house,—while the Fire Alarm Telegraph conveys the first notice of a fire from any part of the city to the Fire Brigade, and to the Wheel-house at the same instant.

THE ESTIMATE.

My instructions do not fix the scale of the Works, but with the exception of the size of the main this is less important in high pressure pumping than in gravitation works, especially since, in the absence of reservoirs, duplicate pumping machinery must be provided; and because for fire purposes, the pumping power must necessarily be in excess of the domestic demand here. The average daily consumption per head in American cities ranges from 25 to 60 gallons. Cities on the salt water, or with large manufacturing establishments, require more than those on fresh water. In Quebec, (where there is great waste,) about 100 gallons per head daily are taken, and under the same system double the quantity would doubtless be disposed of, if the Works could furnish it. In consequence of the high pressure which must necessarily rule in low levels here, it will be advisable to check in the outset, those abuses which have proved so unmanageable at Quebec. It is usual to fix a scale for commencement, allowing 35 to 40 gallons per head for double the present number of inhabitants. In this way a daily capacity of about 1,500,000 gallons is needed, which would be 37½ gallons per head to 40,000 inhabitants. Of course it will be many years before this is reached, not only because there will not be the population, but the consumption per head will not get up to the estimate for some time. During this infancy of the consumption there will be a large surplus of water, which, as the machinery must be kept moving, and the delivery is accompanied with no extra outlay, may as well be worked off through fountains, and thence used to flush the sewers. But other considerations than the probable average daily consumption should govern the provision for supply here.

The Dominion Government require a supply for the Public Buildings, which now costs about $3,000 per annum. When the grounds are completed with the necessary fountains, a much larger quantity will be required for the Summer months, and the City Works will be in a position to supply the whole of a much better quality, and at much less cost; and there is no doubt that this will be done, as soon as it is proved that the supply can be relied on.

As the pipe will be extended down Dalhousie Street to the Railway Station, where water is required in considerable quantity, I have no doubt it will soon be laid across the Rideau and carried up to Rideau Hall; where the supply is now carted at the expense of several hundred dollars annually, and where it must be distributed at probably a greater cost. Fountains may then be erected there, and the cost of watering the grounds be reduced to a minimum.

DISTRIBUTION.

The cost of pumping machinery and water power may be varied, by the quality selected for the one, and the site for the other; but in the important items of pipage and hydrants, where the utmost efficiency is required, the only means of diminishing the outlay is by reducing the quantity or extent with which the Works may be opened.

But on the other hand for the comparatively small extra amount (in proportion to the whole outlay,) which is necessary to give the immediate benefit of the water supply and fire protection to all the settled districts, it would I think be bad policy to restrict the distribution on which the enjoyment of the Works depends.

Ottawa is much less compact in its population than most cities with the same number of inhabitants, and therefore a much greater extent of pipage, to meet all requirements, will be necessary in proportion.

In Hamilton, with the same population as Ottawa, thirteen miles of distributing pipes were considered sufficient; here about twenty-three, exclusive of pumping main, will be required. It is usual to provide about $5 per head for this purpose, and taking the population here at 20,000, about $100,000 should be sufficient, if the people were not so scattered. As it is, this item will here cost about fifty per cent. more. The Map shews the distribution proposed, and in the Appendix a List of the Streets, with the approximate lengths on which the Estimate is based, is given. In the Distribution, while we may economise to the extent of about $25,000, by reducing the length, say six miles,—whatever is done, and as far as it is extended, everything must be the most efficient in plan and execution. We cannot afford to have the streets torn up by failures in the pipes, or the hydrants give way in time of need.

To feed the hydrants efficiently the pipes should not be less than five inches diameter in the high districts, and four inches in the low ones; except in the ends of streets in *cul-de-sacs*, where a smaller size may be employed. In Hamilton nothing less than six inch is used; but as the power here will not cost any more, a little extra pressure will make a smaller size sufficient. The cost of laying and handling being the same, the difference of iron and joints between a four-inch and three-inch pipe is not serious.

A fire nozzle under efficient pressure will deliver at the rate of 200,000 gallons per 24 hours; so that five of these streams would take at the rate of one million gallons in the 24 hours.

The pipes will all be coated when hot, with coal tar, which is an effectual protection against rust and incrustations.

PUMPING MACHINERY.

The Pumping Machinery proposed would consist of two Jonval Turbines, each 5 feet diameter, and 130 to 200 horse power effective, according to speed and head. Pumps, single acting plunger 15 inches diameter, 3 feet stroke, delivering, with 10 per cent allowance for leakage, 1,500,000 gallons per 24 hours, when working at $16\frac{2}{3}$ strokes per minute. Each set of pumps to consist of three, arranged to deliver uniform flow into main, and exert uniform strain on machinery. The gearing to admit of working separately or together, and each wheel to drive either set of pumps, or both, so that part of the pumps may be disconnected for repairs, and the remainder worked independently, if necessary. The machinery to be governed by a self-acting regulator, to maintain suitable pressure for domestic or fire purposes, and change one for the other as required.

The Turbines to be of simple and durable construction, provided with iron trunks and casings, draft tubes, gates, &c., arranged to have working pacts accessible above back water, and take advantage of fluctuations of head and tail water within ordinary limits. The capacity and strength of the Machinery to be such that the full required quantity to meet any fire emergency may be supplied without increasing the speed beyond a perfectly safe limit.

The Regulator proposed is the Holly Hydrostatic Pressure Regulator, in use in Ogdensburg and elsewhere.

In adopting two sets of reciprocating pumps instead of the three under the rotary system (one of the latter being called the domestic pump,) it is desirable that either of these two sets should have capacity to meet the emergency of ordinary fires, having the other in reserve. In this case all that is needed will be to increase the speed of the working pumps on the first fire-signal, and the risk attendant on starting the second set in hurry or excitement is avoided. To start hurriedly a second powerful set of machinery to work into a main already under high pressure, is accompanied with more risk to both machinery and main, and more loss of valuable minutes, than merely to increase the speed of that already in motion—and requires judgment and caution ; and, as a man may be called upon to do this when roused from a sound sleep, and but half awake, it is desirable to avoid it as far as possible.

The pumping main is short, and a considerable proportion of the cost, especially where in rock excavation, is in the laying, so that the cost is not seriously increased by a small addition to the diameter. Moreover, as it really costs no more to drive large pumps by water-power than small ones, and a small increase in their diameter as well as enlargement of the other working parts does not materially affect the cost, except in the quantity of metal, I consider the true policy is to give liberal dimensions to the pumping power, by which means an ample domestic supply is secured, with a low working velocity, and a full fire supply when working at a perfectly safe speed.

PUMPING MAIN.

The size of the pumping main, which will be 14 inches in diameter, is governed by the estimated daily supply required, as well as the demand for fires.

The Machinery and distribution being of the most reliable description, the only contingency would be a failure of the water power, or an accident to the machinery or to pumping main. The water power question has been fully discussed, and the only thing which gives importance to the other considerations is the absence of any provision for storage, common wherever possible to all works except those of the Holly system. This system has been but a few years in use, and, with one or two exceptions in small towns, where the consumption has not reached any considerable amount, and where the absence of the water for a few hours, except during a fire, might not be felt. The chance of accident to the main would be very remote, with a reservoir system limiting the pressure,—and should be equally guarded against by proper safety valves; but such an accident may result from neglect or mismanagement: and although I do not think the chances are such as to warrant any considerable outlay to provide against them, it is necessary that it should be understood, that for the sake of economy, a risk, however slight, is assumed. An extra expenditure of about $12,500 would provide a double pumping main, and this would duplicate the system throughout. But a much smaller sum would provide sufficient storage to meet any probable stoppage of the supply.

The objection to a duplicate main is, that, to be thoroughly efficient, it would require a double set of branch pipes and stop-cocks, so that a reservoir would be by far the cheaper provision. The larger pipes of the distribution through streets parallel to the route of the pumping main may, with proper arrangement of valves, be used as a duplicate in emergencies—so far as they can be made a substitute for any damaged or unwatered portion of the main.

RESERVOIRS.

To secure such important customers as the Public Buildings, some storage would be needed if none existed; but as there are Water Tanks there, and as the existing works would doubtless be kept in readiness to meet any emergency, I do not think reservoir provision absolutely necessary on that account; and with two complete sets of machinery suited to domestic or fire service, one ought to be always in working order.

The fact that the Holly system produces a fire pressure when reservoirs could not do the same, has induced some persons to undervalue reservoirs of all kinds. As has already been explained the reservoirs at Montreal and Hamilton may be useless while the pumps are in motion, yet it would be as absurd to ignore their value as for a man who was earning more than his expenses to despise his balance in the Savings' Bank.

Any water works system without a reservoir must be to a certain extent helpless under many circumstances; or, if all these are guarded against, the extra outlay for this purpose may exceed the cost of a reservoir. The pumping main cannot be unwatered for an hour, therefore every branch pipe leading from it must be commanded by a stop-cock, and if one of these becomes deranged, it can only be put right by stopping the pumps. For these reasons a reservoir with only capacity for one day's supply is invaluable to any city.

I have provided a small sum of $5,000 for such a reservoir, but circumstances mayrender even this small outlay unnecessary.

The Montreal reservoirs only contain about twoday's summer consumption, at the present time. The chief reliance there is on the machinery.

There are only two sites sufficiently elevated to keep all the pipes full; the one on Ashburnham, the other on Barrack Hill. At the former place the conditions are favorable for a cheap reservoir. The latter would be more central, and much nearer the route of the pumping main, but it is prohibited to the City as Government Property, as well as by the cost of rock excavation. But it is highly probable that in connection with the laying out and improvement of these grounds, some ornamental water would be provided for,if the proper supply could be secured. Such a sheet of water placed near the flag-staff would work the fountains in front of the Parliament Buildings, and answer all the purposes of a reservoir for the City Works, for the contingences referred to.

The summary of the Estimate, according to the foregoing principles is:

Distribution with 24½ miles of pipage, including main from Victoria Island	$180,000
Pumping Machinery and Building	25,000
Water Power at Victoria Island	5,000
Reservoir, Ashburnham Hill	5,000
Fire Alarm Telegraph	10,000
	$225,000
Contingencies, Superintendence, &c., &c,	25,000
	$250,000

I have taken of course the cheapest of the water-power plans in the Estimate, and have not provided for any deepening of the Slide Channel.

The prices are liberal, and everything is designed to give a complete and efficient system, equal to the best, and superior to that in most cities. It would be possible (if necessary) considerably to reduce this Estimate, by diminishing the distribution, postponing Telegraph and Reservoir, and economizing a little more in the Wheel-house. It might be possible thus to keep down the cash cost so as not much to exceed two hundred thousand dollars. But I think it would be the worst possible policy to do so. The Fire Alarm Telegraph would practically double the efficiency of the Works in their most important aspect, and would, with a reservoir, however small, give that confidence to the Insurance Companies, which would secure the fullest reduction in the rates.

As to the distribution,—in a work to be undertaken by the whole city, it ought in common fairness to be at once extended as far as possible.

It will thus be seen that the amount is considerably within the limits fixed in my instructions. I do not think it possible to have anywhere, or under any system, (save one with a high level Reservoir,) better Works, or for less money than in Ottawa; and as a consequence of this highly favorable condition of things, water can be supplied here at the lowest rates,—lower than it can be obtained by any other means. It can be furnished to the poor at less cost than the value of their labor in bringing it from the river; and to the rich, for less than the annual cost of keeping wells, pumps and cisterns in order. For all the smaller houses of the working class, I think the water rate need not exceed five dollars per annum.

COMPARATIVE COST OF WATER POWERS.

The comparative excavation required for a canal 20 feet wide, and 10 feet below water level of March last, on the different routes, is as follows :—

1—Gully Route,	30,710	cubic yards.
2—Queen Street,	34,460	"
3—Oregon Street,	27,000	"
4—Amelia Island,	7,300	"
5—Victoria Island,	5,750	"

In the last two cases is included 5,000 cubic yards for the deepening of the Slide channel to same bottom level as the other canals, which may not be required.

The comparative cost would be approximately as follows :—

1—Gully Route, open Canal and three Bridges,	$50,000
2—Queen Street, covered with Cedar Logs,	60,000
3—Oregon Street, do do do	45,000
4—Amelia Island, including raising Slide,	15,000
5—Victoria Island, do do do	10,000

The cost of land is not embraced in any of the water-power estimates. The extra cost caused by extending pumping main from Pooley's Bridge to Victoria Island will be about $3,600, which should be added to the last three routes to compare them fairly with the first two. On the other hand, if the Slide channel be not deepened, $5,000 may be deducted from above estimates.

The cost of deepening the Slide channel (should it be found necessary) cannot be determined until the conditions, under which the work must be done, are known, and this rests altogether with the Government.

REVENUE.

The return which may reasonably be expected will depend on the number of the consumers, and therefore on the extent of the distribution.

Within the limits proposed there should be at least one thousand ordinary tenants, from whom an average annual rate of $8 may be expected. In addition to these there will be special rates for baths, water closets, bakeries, breweries, confectioneries, slaughter-houses, livery stables, hotels, saloons, printing offices, steam engines and manufactures of various descriptions, which may be estimated at nearly 40 per cent on the ordinary rate. The proprietor of the Russell House informs me that it costs about $1,000 per annum to cart water to that establishment. A confectioner and baker says water costs a dollar a day for the three hot months.

If the Government pay for fountains in proportion to the cost at present, we might expect :—

Supply to Public Buildings and Grounds,	$4,000
1,000 ordinary Tenants, at $8 per head,	8,000
Special Rates,	3,000
	$15,000

The expenses of the Fire Department last year were $6,500, and to water Sappers' Bridge about $75 was paid. All other street watering was done by proprietors, and the cost is not known.

The annual charge for the Brigade, including the Telegraph and the management of the Water Works, would, I think, be considerably less than the above amount; so that the revenue of $15,000, or six per cent. upon the Estimate, would not be an unreasonable expectation.

This favorable result in direct Revenue, so unusual in the early history of Water-Works, can only be ascribed to the very low cost at which they may be attained: but it is only a part, and probably the least important part, of their remunerative character.

As a matter of public and private economy, it would not be difficult to prove that instead of the extremely limited quantity and inferior quality of water which is now obtained by horse-power and man-power, and retained, distributed and elevated by an expensive system of wells, cisterns, pumps and servants, a profuse supply of far superior quality could be forced up by water power, and drawn off on any inhabited level, by the simple turning of a tap.

In a commercial view the value of a soft water supply like that of Ottawa is very great. It makes all parts of the City, where the pipes extend, equally available for many classes of manufactures, and from this cause, as well as the superiority of the quality over well water, for steam engines and some branches of business, it leads to the introduction of manufactures which would otherwise go elsewhere. Moreover, an efficient water supply would not be without its influence in determining the residence of many persons of leisure and means.

A most important consideration which leads to the selection of a particular town for every kind of establishment, is the question of Insurance. If it be established that large stocks of provisions, manufactures, etc., may be held here as safe from the ravages of fire as elsewhere, and at the lowest rates of Insurance, Ottawa will continue to be the depot of the Ottawa Valley, and of the supplies for its great Lumber Trade for all future time.

Mr. Alfred Perry, of Montreal, whose position as Inspector of the Royal Insurance Company, makes him the best authority upon the subject, states, that the losses by fire in Ottawa in the last four years have exceeded half a million of dollars, of which the Insurance Companies paid $280,000, and the Proprietors $240,000. The losses of 1868 exceeded $200,000.

First-class rates, which in Montreal are 5*s.*, are in Ottawa 10*s.*; Second-class, which in Ottawa are 22*s.* 6*d.*, are only 12*s.* 6*d.* in Montreal; while Third-class risks which will scarcely be taken here at 50*s.*, can be insured in Montreal at 20*s.* In consequence of these high rates, one half of the property here, he says, is uninsured; and he justly observes that the effect of an efficient water supply would not only be a great reduction of rates, but also of the necessity for insuring to so great an extent. Where $1,000 is now insured with the certainty of total loss in case of fire, $600 would do in the prospect of only a partial loss.

He estimates the amount now annually paid for water at $20,000—say one dollar per head on the population—or more than the interest on the cost of water works. He states the annual amount paid for Fire Insurance to be $70,000, and this is a fact he has the best means of knowing. In Hamilton in 1857, with about the same population, from an exact Return furnished to me by every Insurance Company doing business there, I found the insured value was once $6,200,000, on which the annual charge was $59,000, or nearly one per cent. Whether the valuation in Ottawa be at all in proportion to that of Hamilton, for the same population, or not, there is no doubt that the average rate here is much higher, and a reduction of only 25 per cent on $70,000 would effect an annual saving greater than the interest upon the cost of the works.

Mr. Perry (whose practical experience as a Fireman is unsurpassed) fixes the quantity of water required for a large fire at 1,500 gallons per minute, or at the rate of a daily supply of little over two million gallons; but, he says if got at early, 500 gallons per minute would do. This would be about three streams. Mr. Bertram, Chief of the Montreal Fire Brigade, who keeps a record of the number of hydrant streams played at each fire, states that the majority of fires are extinguished with two or three streams. This is due altogether to the Fire-Alarm Telegraph.

But there are considerations connected with such a water supply to which no value can be attached. In all cities so much of the ground becomes covered with buildings, paved roads and court yards, that natural filtration is prevented, and the rains wash all the street and yard impurities, unfiltered, into the wells, soon rendering them unfit for use.

In Ottawa the building lots are only 99 feet in depth, and where houses, stables, cesspools, drains, &c. are established on every chain of frontage, wells cannot be used with impunity. There is no more insidious or dangerous enemy to the public health than impure water, and well water, though clear, and apparently pure, may contain pestilential matter in solution. The ravages of Cholera have been observed to vary with the efficiency or otherwise of the Water supply in different parts of London. Dr. Sterry Hunt, in his analysis of the Ottawa and St. Lawrence waters, (see Appendix), shows that in 1854 (when the population of Montreal was but one half its present number) the local impurities caused by the sewage could be easily detected in the water pumped from the river in front of the city —and this was one of the chief reasons for going to the head of the Lachine Rapids for a pure supply. If Montreal in that day could poison the St. Lawrence on her front, the same result may be expected here.

Finally, there will be in all cities a class to whom the water must be taken to induce them to use it—a class which generally congregates together, and amongst whom sanitary regulations are powerless, unless backed by an efficient supply of water. Where water has to be carried up a hill nearly 100 feet high, it is practically out of the reach of thousands, although living on the banks of a mighty river—the widow, the cripple, the tired laborer, cannot or will not carry more than is absolutely necessary—and hence, in these districts, epidemic diseases obtain a foot-hold, from which they cannot easily be dislodged, and within which they cannot be confined.

THOS. C. KEEFER.

APPENDIX No. 1.

HOLLY MANUFACTURING COMPANY,
LOCKPORT, N. Y., 24th April, 1869.

THOMAS C. KEEFER, ESQ.,
Engineer, &c.,
New Edinburgh, Ontario.

DEAR SIR,—

In accordance with your request we herewith send you estimate of costs of Machinery for furnishing 1,000,000 gallons water per 24 hours, and distributing the same for domestic use, in the City of Ottawa, under a pressure to force it to a height of 150 feet above source of supply, for domestic use ; also with capacity to deliver 3,000,000 gallons, and force the same through mains laid in said city, (of sufficient capacity) with a pressure which we will guarantee will throw fire streams with great force from the hydrants, located 150 feet above the source, without any intervening power.

The Machinery will consist of two Holly's Patent Elliptical Rotary Pumps, mounted on separate iron frames, and one Gang Piston Pump, larger size, but similar in style to that shown you when here. Also, three 6 feet Water Wheels of combined power equal to 500 horse, and shafts. Also, one Hydrostatic Pressure Guage and Regulator, for the purpose of controlling the pressure of water in the pipes, and of changing the same at the pleasure of the operator, as may be needed for fire or domestic use ; all to be upon an Iron frame, and will be so arranged that the power of either wheel can be applied to either or all the pumps,—thus, in reality, giving you the safeguard of three sets of works, each complete in itself. Also, all Sliding Couplings, Water Guages, Valves, Bridgetrees, Air Chambers, Suction Air Chambers, Hydrostatic Safety Valves to discharge surplus water from pipes while Self-Acting Pressure Guage is shutting off power ; also, all connecting Water Pipes, and all Gearing, Shafting and Belting needed inside the Pump-House ; also, 6 large Sheet Valves, and in short everything necessary to use inside the Pump-House to render the

Machinery complete, and adapted to throw through said mains and hydrants, from points at average altitude in said city, 8 one inch streams of water at the same time, 100 feet high, from points 150 feet above source of supply, 6 one inch streams 80 feet high, or 4 one inch streams 100 feet high.

The cost of above Machinery, delivered and set up in building to be erected by your City, and the duty to be paid by City of Ottawa, but the whole to be put in perfect working order and warranted, will be $25,000 in Gold.

We should make the Pumps and Machinery for the service and this head in the most perfect manner, and from new patterns adapted especially to the service, and in furnishing the other Machinery, such as Water-Wheels, Gearing, &c., should endeavor to get all built at Ottawa that can possibly be procured there. We can also furnish our improved Hydrants with Iron case, either with or without lower valve, delivered, subject to duty, at a very moderate price ; or will furnish you patterns on very moderate terms, which will enable you to make them at Ottawa.

Yours truly,

(Signed), CHARLES KEEP,

Secretary.

APPENDIX No. 2.

OTTAWA WATER WORKS.

Estimate *of Pipeage for full present Distribution.*—23 *Miles.*

STREETS.	Lineal ft. Pipeage		Diameter.	Total.		Sum
	In Rock.	In Earth.		In Rock.	In Earth.	Total.
Timber Slide to Bank, *via* Well'ton	5200	......	14			
Bank to Elgin....................	......	1500	"			
				5200	1500	$6700
Elgin to Ottawa	2800	......	12	2800	......	2800
Rideau—Ottawa to Augusta	......	2750	8			
Dalhousie—Rideau to R'y Depot ...	......	3500	"			
				......	6250	6250
Lloyd—Duke to Ottawa Street....	850					
Victoria Terrace—Lloyd to........	550					
Do. to Albert........	250					
Albert—Vict. Terrace to Con. Road.	1550					
Bay—Wellington to Albert	700					
Bay—Albert to Biddy	......	1200				
Bank—Wellington to Biddy......	......	2100				
Elgin— Do. to Maria	......	1440				
Ottawa—Rideau to Wilbrod	......	1050				
King— Do. to St. Andrew....	......	2150				
Nelson— Do. to Wilbrod.......	......	1050				
Augusta—Franklin to Stewart	......	1800				
Rideau—Augusta to Prot. Hospital	......	1200				
Middle Street—Victoria Island.....	1000					
Oregon—Bridge to Broad.........	550					
Queen—Broad to Duke...........	1100					
Ottawa— Do. to Cathcart	1050					
Broad—Ottawa to Oregon........	1200					
Sherwood—Do. to do.	1200					
Bridge—Ottawa to Duke	1150					
Cathcart— Do. to Queen	350					
Britannia Terrace throughout	1300					
At McGillivray's—Wellington to beyond Victoria	500					
Hugh—Wellington to Victoria....	450					
Bank— Do. to do.	300					
Victoria— to Bank	1350					
Little Sussex—Sussex and Metcalfe, St. Paul to Metcalfe Square.....	4300					
William—Rideau to York.........	700					

ESTIMATE OF PIPEAGE.—*Continued.*

STREETS.	Lineal ft. Pipeage In Rock.	Lineal ft. Pipeage In Earth.	Diameter.	Total. In Rock.	Total. In Earth.	Sum Total.
Cathcart, *Bolton* (twice), *St. Andrew*, *Church*, *St. Patrick*, *Murray*, *Clarence*, *York* and *George*, say from Sussex to Dalhousie, 1150 ft. each	11500					
Victoria—Bank to Lloyd	......	1000				
Do. to Pooley's Bridge.	......	750				
Richmond Road—Victoria to Albert	......	1100				
Small Street—off Richmond Road..	......	300				
Division—off Richmond Road.....	......	300				
Sally—Wellington to Queen......	......	550				
Hugh—Wellington to Queen	......	500				
Do. Slater to Nepean	......	900				
Metcalfe—Wellington to Maria	......	1300				
Sparks—Elgin to Christ Church...	......	3800				
Queen—Sally to Hugh	......	650				
Do. O'Connor to Elgin.........	......	1200				
Do. Elgin to Canal	......	300				
Albert—Bank to O'Connor.........	......	550				
Do. Metcalfe to Market Square.	......	750				
Maria—Bay to Elgin	......	3450				
Rideau to Canal Basin	......	500				
Mosgrove—Do. to do.	......	500				
Nicholas—Rideau to Stewart......	......	800				
Besserer—Nicholas to Augusta.....	......	3350				
Daly—Nicholas to Augusta........	......	3350				
Stewart—Ottawa to do.	......	2950				
Wilbrod— Do. to Chapel	......	2500				
Bolton (*N. W.*)—Dalhousie to King	......	1150				
Cathcart— Do. to do.	......	1250				
Bolton (*S. E.*), *St. Andrew*, *Church*, *St. Patrick*, *Murray*, *Clarence*, and *York*—from Dalhousie to King .	......	8500				
George—Dalhousie to Cumberland	......	600				
Ottawa—King to near Charlotte...	......	2500				
Parry— Do. to Chapel	......	1400				
Franklin—Augusta to Cobourg....	......	450				
Cumberland—Rideau to Cathcart ..	......	2650				
King—Park to Bolton	......	700				
Nelson—Rideau to Ottawa........	......	1550				
Gloucester—Do. to Park	......	2100				
Chapel— Do. to Ottawa	......	1550				
Augusta— Do. to Franklin.......	......	1000				
Cobourg—Franklin to Ottawa	......	550				
Napoleon—King to Rose	......	600				
Rose—Park to end..............	......	350				
McGee—Park to Ottawa	......	500				
St. Joseph—Park to Ottawa	......	500				
				31900	78990	$71240

ESTIMATE OF PIPEAGE.—*Continued.*

STREETS.	Lineal ft. Pipeage		Diameter.	Total.		Sum Total.
	In Rock.	In Earth.		In Rock.	In Earth.	
145 Hydrant Connecting Pipes, say 10 feet each, half rock.........	750	700		750	700	$1450
York—Dalhousie to William	400					
Do. Sussex to do.	......	700				
George—Do. to Mosgrove	......	400				
Mosgrove—Rideau to George......	......	250				
				400	1350	1750
Maria—Bay to Concession........	......	850				
Gloucester—Ashburnham to do. ..	......	850				
Nepean— Do. to do. ..	......	850				
York—Sussex to Dalhousie.......	1150					
George—Do. to William	......	700				
Water Street—King to Rideau.....	......	600				
Parliament—Ottawa to Park......	......	500				
Dalhousie—Railway to Baird......	......	500				
Redpath—Dalhousie to Carleton...	......	800				
Baird— Do. to do. ...	......	800				
				1150	6450	7600
	42200	87490		42200	87490	129690

From the best information which could be obtained, about one-third of the pipeage will be in rock excavation.

APPENDIX No. 3.

THE HIGH PRESSURE SYSTEM FOR FIRE EXTINCTION.

In a paper read by the late Mr. Braidwood, when Superintendent of the London Fire Brigade, before the Society of Arts in 1856, he says :—

" From 1838 to 1843, £776,762 were lost in Liverpool by fire, almost " entirely in warehouse risks. The consequence was that the Mercantile " rates of Insurance gradually rose from about 8 per cent to 30, 40, and it " is said in some cases to 45 per cent.

" In Liverpool, Manchester, and other cities, the extinction of fires by " the pressure of water only, without the use of fire engines, is very much " practised. The advantages of this system are very great.

" The supply of water is the most vital part of any exertions towards " extinguishing fires. Where the pressure is sufficient, and the mains " large enough, by far the most economical mode of using the water is to " attach the hose directly to the mains."

On the discussion which followed the reading of the paper, Mr. Chadwick, C. B. said :—" He (Mr. Chadwick) had got the Police to note the " time which elapsed between the first alarm of fires and the arrival of the " engines, and the return upon the first group of observations, was thirty- " six minutes. It appeared that the engines traversed the streets, allowing " for obstacles, at a rate of ten miles an hour. Information would be con- " veyed to the stations of the brigade at a rate of five miles an hour. In " the case of the occurence of a fire within a mile of the station, the infor- " mation would be conveyed in twelve minutes, the horses would be put " to, and engines got out in about five minutes on the average ; it trav- " ersed the distance and arrived at the fire in about six minutes more ; " the water had to be got, and got into the engine, which would occupy " about five minutes, making about twenty-eight minutes, or for half a mile " distance, an average of not less than twenty minutes, which must occur " under the most favorable circumstances. This arrangement he could " not but consider as fatally slow. A pail full of water might suffice

" within the first minute after ignition, in the second minute more than a " ton weight would be required.

" On an impartial consideration of the facts, he was confident that " practical concurrences would eventually be given to the conclusion at " which he had arrived, that the principle of all future arrangements for " the repression of fires, must be a constant supply of water kept at high " pressure, night as well as day, and the direct application of it from the " mains before the door, by means of a hose and jet. By that arrange- " ment he had proved that a power equivalent to three or four of the best " engines might be kept constantly before each door ready for application " within two minutes.

" Mr. Baddely, who had attended all the principal fires which had " occurred in the Metropolis during the last thirty years, and who had given " anxious attention to the subject of the water supply, had testified that " by arrangements which should ensure the application of water to fires " within even five minutes after their commencement, the progress of " two-thirds of them wonld be effectually arrested. Mr. Wm. Lindley, " the Engineer, who had re-built that portion of the City of Hamburgh, " which had been burnt down, and who had stated that, in that rebuilding " he had been guided in his arrangements for house and main drainage, " and water supply, by the principles laid down in his (Mr. Chadwick's) " sanitory report, had given, in respect to the arrangements of the water " supply, the following testimony which was complete and conclusive in " itself :—

Mr. Lindley was asked,—

" Is the jet used at Hamburgh for watering the streets ?" " Yes ; " and the charge has been one penny per foot of frontage per annmm."

" What provision is made with the new system of works which you " have laid down for the prevention of fires ?" " The mains are large— " from 6 to 20 inches diameter—constantly charged at high pressure, " being supplied from the one extremity by two Cornish engines, and at " the other level from a high summit reservoir, kept constantly filled ; " throughout the whole length of the pipage are placed, at intervals of 40 " yards, fire plugs of 3 inches diameter in the clear."

" How soon can a jet be applied for the extinction of fires ?" " In " two minutes."

" Have there been fires in buildings in Hamburgh in the portion of " the town rebuilt ?" Yes, repeatedly. They have all, however, been put " out at once. If they had had to wait the usual time for engines and " water—say twenty minutes or half an hour—these might all have led to " extensive conflagrations."

" What has been the effect on insurance ?" " The effect of the rapid " extinction of fires has brought to light, to the citizens of Hamburgh, the " fact that the greater proportion of their fires is the work of incendiaries, " for the sake of insurance money. A person is absent ; smoke is seen to " exude ; the alarm of fire is given, and the door is forced open, the jet " applied, and the fire extinguished immediately. Case after case has " occurred, where, upon the fire being extinguished, the arrangements of " incendiaries for the spread of fire are found, and made manifest. Several " of this class of incendiaries for the insurance money are now in prison. " The saving of money alone, by the prevention of fires, would be worth " the whole expense of the like arrangements in London, where it is well " known that similar practices prevail extensively."

APPENDIX No. 4.

DR. STERRY HUNT'S ANALYSIS OF OTTAWA WATER.

MONTREAL, 18th April, 1854.

MY DEAR SIR,—

I have submitted to a chemical examination the waters of the St. Lawrence and Ottawa Rivers, collected above their junction, as well as the waters of the united current below Lachine, and that supplied to Montreal by the City Water Works. The water of the Ottawa was taken by me in company with yourself, on the 9th March last, at the head of the Ste. Anne Lock, where there could be no admixture with the St. Lawrence; and on the same day we took a specimen three miles below Lachine, at the point where the Corporation are about to obtain the supply for the new City Water Works, and about 30 feet from the shore. I collected the St. Lawrence water on the 30th March, at about 100 feet from the shore, on the South side of the Pointe-des-Cascades, at Vaudreuil, not far below the rapids. A portion of water was also taken from the well at the City Water Works on the 15th March. All of these specimens were thus collected before the melting of the snows, and may be regarded as representing the average character of the waters.

The water of the St. Lawrence, which is pure green in a large body, appears completely destitute of color when in masses of only ten or twelve inches in thickness, while the fine amber-brown hue of the Ottawa water is very distinctly seen in a common drinking glass. The water from Lachine and that of the City are nearly alike in color, and while partaking of the brown hue of the Ottawa, have, as I find by comparison, the tint of a mixture containing one part of this and two of pure St. Lawrence water. The waters are all bright and transparent, and deposit a very small amount of brownish sediment, which adheres firmly to the bottom of the bottles; the City water contains the most, and the St. Lawrence the least. When the Ottawa water is boiled, it deposits a mixture of earthy carbonates and selica, colored dark brown, by the presence of a considerable amount of vegetable matter, which the recent water holds in solution. Owing to this admixture, the deposit is not so dense as in the other waters, and adheres but slightly to the interior of the glass vessel in which it is boiled. This vegetable matter which colors the water of the Ottawa, is, without doubt, derived from the peat bogs, which are abundant in the regions drained by this river. It is only in part precipitated by boiling, and the water when evaporated to a small bulk, has the color of brown sherry wine. When the water of the St. Lawrence is boiled, it gives a white chrystalline deposit, which is more abundant than that from the Ottawa, and adheres firmly to the surface of the vessel. There is but little color in the evaporated water, showing that vegetable matter is present only in very small quantity. The other specimens are mixtures of the two waters in which the St. Lawrence predominates, and yield by boiling crystalline deposits, colored by vegetable matter.

The most important results of my analysis are given in the following Table ; they are the means of two or more closely accordant determinations, and are calculated for 100,000 parts :—

	Ste. Anne.	Lachine.	City W. Works.	Cascades.
Carbonate of Lime,	2.480	6.440	7.400	8.033
Carbonate of Magnesium,	.696	1.970	2.160	2.537
Silica	2.060	3.250	3.450	2.380
Chlorine,	.076	.152	.296	.242
Sulphuric Acid,	.161	.487	.498	.687
Alkalies (as Chlorids)	.900	1.310	not deter.	1.500

No attempt is here made to show the distribution of the sulphuric acid and chlorine among the bases, and further enquiries are necessary to decide some questions of theoretical interest ; but the above table shews all that is necessary in order to judge of the fitness of these waters, for the ordinary purposes of life. The results of my further examinations when completed, will be given in the Report of the Geological Survey. It may be mentioned that in all these waters minute portions of phosphoric acid, alumina, and of the oxydes of iron and maganese have been detected ; the quantity of maganese is greater in the St. Lawrence, but the Ottawa contains more iron. A portion of the vegetable matter in the latter water exists in the form of crenic acid, which has been found in many other natural waters. When evaporated to a small volume, these waters still retain a portion of silica in solution and a little lime, which in the Ste. Anne water amounts to .13 and in the Cascades to .28 in 100,000 parts.

It will be seen from the table, that the waters of the St. Lawrence are already mingled with the Ottawa at Lachine, for the water at the head of the Lachine Rapids near the shore of the Island of Montreal, has the composition of a mixture of two parts of St. Lawrence with one of Ottawa water. In that from the City Water Works the admixture of St. Lawrence water is much greater, the proportions being about five to one. It must be remembered that the volume of the Ottawa varies greatly with the season, the water being lowest in February and September. In June and October when its volume is very much increased, the proportion of St. Lawrence water near the shore of the Island, will doubtless be much less than at the time when these specimens were taken.

It is important to remark that the amount of chlorids contained in the water at present supplied to the City, is greater than in the St. Lawrence water. Another sample drawn from a hydrant on the 11th of April, gave .284 of chlorine, and a partial analysis of the water from the same source, made in the Spring of 1850, showed a similar excess of chlorine. The results calculated for 100,000 parts were :—

Carbonate of Lime,	7.550
Carbonate of Magnesia,	2.044
Chlorine,	.297
Sulphuric Acid,	.447

This constant excess of chlorids shews that there is a local source of impurity, probably the drainage of the City, which always affords a large supply of such salts.

The whole amount of solid matter, left after heating to redness the residue from the evaporation of the different waters, will enable us to make some comparisons with the water supplied to other cities. I give the results obtained by Prof. Silliman, with the Croton Water of New York, the Schuylkill of Philadelphia, the Cochituate water of Boston, and that from the River St. Charles above Indian Lorette, at the point where it is taken for the supply of Quebec.

The results are calculated so as to shew the amount of fixed residue in an imperial gallon of ten pounds avoirdupois, or 70.000 grains :

Ottawa, Ste. Anne,	3.73 grains.
St. Lawrence, Cascades	10.76 "

Lachine,	8.41	grains.
City Water Works,	9.62	"
Croton, New York,	7.98	"
Schuylkill, Philadelphia,	4.95	"
Cochituate, Boston,	1.46	"
St. Charles, Quebec	2.45	"

It will thus be seen that while the water from Lachine with which our City is to be supplied is less pure than those of Quebec or Boston, it differs very little from the Croton, and is decidedly to be preferred to the unmixed water of the St. Lawrence, or to our present supply. *The great purity of the Ottawa is more than sufficient to counterbalance the objection which its color offers, and it is therefore an important consideration that during a great part of the year the increased bulk of the Ottawa will give us at Lachine a supply of the water of this river, with very little mixture of the St. Lawrence.*

The action of these waters upon lead is a question of interest. It is known that natural waters containing a considerable amount of soluble salts, especially sulphates, have less action upon this metal than purer waters; but I have found that both the St. Lawrence and Ottawa waters take into solution a certain portion of the lead, the latter somewhat the larger quantity. The contact of brass with the lead increases the action of the water, probably by a galvanic action; while in contact with iron on the contrary, the lead remained bright, and was less affected; the iron meanwhile was considerably corroded with the formation of red iron rust. The protecting influence which the iron mains might exercise over the ends of the lead pipes joined to them would, however, be in a great measure counteracted by the brass cocks.

I remain, my dear Sir,

Very sincerely yours,

(Signed) T. STERRY HUNT.

T. C. Keefer, Esq.