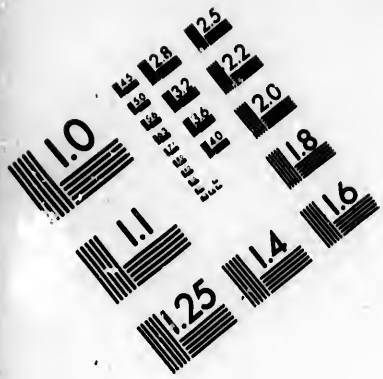


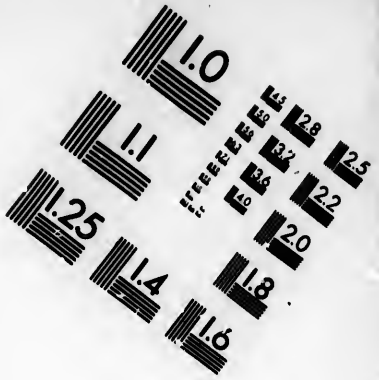


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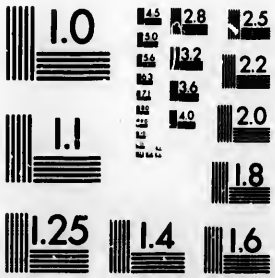


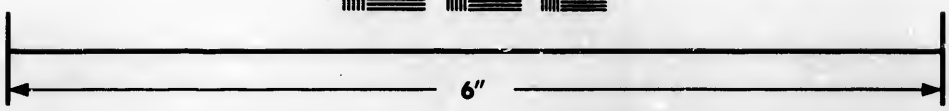




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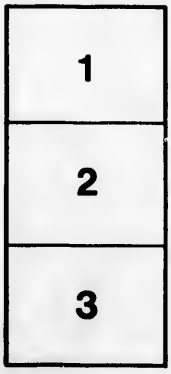


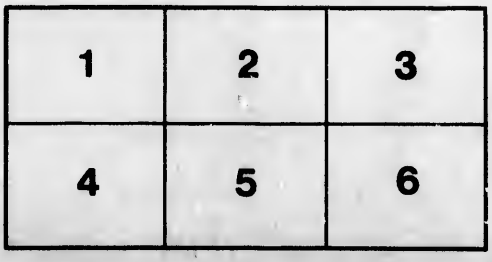

# REPORT

ON

# A WATER SUPPLY,

FOR THE

# CITY OF TORONTO,

BY

THOS. C. KEEFER, ESQ., C. E.

TORONTO:
MACLEAR, THOMAS & CO., PRINTERS, KING ST. EAST.
1857.

# REPORT.

TORONTO, JUNE 1, 1857.

CHARLES DALY, ESQ.,

*City Clerk, Corporation of Toronto.*

SIR,

In accordance with the instructions contained in your letter of the 31st December last, I have made the necessary examinations for a supply of water to the City of Toronto.

My instructions were "to make the necessary surveys and plans for Water Works for the City of Toronto, under the direction of the Standing Committee on Fire, Water and Gas," and, upon subsequent conference with that Committee, the scale of the proposed works was fixed at an average daily supply of forty gallons per head for a population of 100,000, or four million gallons.

The terms of the resolution of the City Council imposed upon me the responsibility of recommending the best plan of supply without reference to the source from whence or the system by which it was to be obtained,—and as Lake Ontario offers an inexhaustible supply of good water, to be had by steam pumping, it became my duty, first, to ascertain whether the city could be supplied by gravitation, and if not, then to determine which were the best positions for the pumping engines and for the distributing reservoirs.

## THE GRAVITATION SUPPLY.

The northern coast of Ontario, adjacent to Toronto, rises by regular slopes and successive terraces from the lake shore to the dividing ridge or summit which bounds the watershed of Lake Simcoe, attaining an average elevation of nearly 1000 feet above Lake Ontario in an average distance of about 22 miles.

The minimum rain fall, as observed since 1843 at Toronto, is 26.805 inches, and of this we may assume that one foot is the proportion which, in the driest years, would pass off by the Humber and the Don, (the two streams which drain the area available for Toronto,) the remainder being lost in evaporation and consumed by vegetation.

The area drained by the Humber and the West Don (above the points where their waters could be abstracted at a sufficient height for the supply of the city) is approximately 300 square miles, and one foot of available water per annum from the whole of this surface would, if the flood waters could all be stored, yield an average daily supply of about 23,000,000 cubic feet, or nearly 16,000 cubic feet per minute. The required supply of 4,000,000 gallons would only be 642,070 cubic feet per diem, or 445 cubic feet per minute.

There can be no doubt therefore as to the existence of a sufficient quantity of water above the required elevation, and within a reasonable distance of the city, to afford a gravitation supply—but, in consequence of many qualifying circumstances, it became a question whether the cost of the necessarily expensive and extensive surveys required for this mode of supply would be warranted by the prospective results.

The Don has three branches which unite at a point too low to command the city; and, as this stream has cut out deep vallies for its bed, these branches cannot (on account of the height of the intervening banks) be combined at a higher level. The West Don, although not the longest branch, has the character of being more steady than the north one; and as it receives the drainage of some fifty or sixty square miles above Yonge Street, which is the point to which it would be necessary to go to obtain the necessary elevation (*i.e.*, 200 feet above Lake Ontario), it should be capable of affording the supply required. One foot of available annual rain fall gives 53 cubic feet per minute throughout the year from every square mile; the drainage therefore of nine square miles should afford the required quantity,—but in practice a portion only of the floods could be secured.

In consequence of the depth of the valley at Hogg's Hollow it is not practicable to take a conduit out of it and enter the city directly by Yonge-street. It would be necessary therefore to follow the sinuosities of the valley to the Cemetery or Charles-street, and, on account of the height and steepness of the main banks of both the Don and Humber, as well as from the number of ravines cutting through

them, an aqueduct or level conduit could not be employed: iron pipes occupying the "flats" or intervale lands would be necessary.

To obtain a supply from the Humber it would be necessary to go above Mr. Boulton's Mills, nearly as far as the Vaughan line. A level of 200 feet above Lake Ontario could be obtained here, which could be taken out of the Humber valley about a mile above the Grand Trunk Railway Bridge, and transferred to Black Creek, near Snyder's Saw Mill, and thence conducted to a distributing reservoir under the Davenport Road—at its intersection with the western limit of the city produced. This reservoir would have a water level one hundred and seventy-eight feet above the lake, allowing 22 feet for loss of head in the pipe.

There has not been any opportunity afforded for examining the condition of these two streams at their lowest stages in midsummer, but very little importance can be attached to guagings, which do not embrace a longer period than was at our disposal, and also comprehend one of the driest years. The true test of the capacity of the streams is to be found in their drainage area and in the minimum rain fall of the district. This rain fall and this area, however, are of little value (where the ordinary flow is insufficient for all requirements,) unless there be storage room in the valleys of the respective streams sufficient to impound the surplus waters of the wet months, (and if necessary of the wet years,) to be fed out during dry ones.

It would appear from the statements of the millers, that at lowest water there is but little difference between the flow of the Humber and the West Don, although the former drains nearly five times as large an area. This may be accounted for by differences in the soil, the Humber throwing off its floods more rapidly, while the Don stores them up in a porous soil, giving a more constant supply by means of numerous springs.

In order to obtain a supply from the Humber or the Don, all the mills below the point of abstraction of the water must be compensated, either in money or by a system of storage, by which their present supply would be guaranteed them. As the required level could not be had from the Humber nearer than the Vaughan line, it would be necessary to buy out or compensate all the mills upon the main stream in the Township of York.

The consumption of the city would be greatest in the season of drought, and therefore would, during low water, so reduce the mill supply as to stop all machinery, thus virtually absorbing the whole stream.

To maintain the ordinary supply to the mills, by the construction of compensating reservoirs, is not only attended with legislative difficulties, but in the present case (all the water powers being occupied and the valleys cultivated) these reservoirs could only be formed by the destruction of valuable properties. In all such reservoirs there is necessarily a large proportion of shoal water, and the draught being greatest in hot weather, many acres would be laid dry at this season—which would no doubt be strongly objected to in the populous and fertile district watered by the Humber and Don.

If Lake Ontario were a body of salt water, instead of fresh, there is little question that the Humber would be selected as the source of a water supply, but in the present case it is chiefly a question of cost. Where the supply can be obtained directly from a natural reservoir, or lake of good water sufficiently elevated, the gravitation system possesses great advantages over any other; but where it is to be obtained from a comparatively small stream, subject to floods, and traversing a soluble soil, and where high dams and large storage basins are required, the variable quality of the water at different periods, and the risk of accident to the dams during floods and ice freshets, (such as that of February last,) are great drawbacks. But the particular difficulty in the present case arises from the occupation of the Humber by mills, making even an approximate estimate of the ultimate cost very uncertain, inasmuch as that cost would be contingent upon legislation hereafter to be taken.

There are two courses open to the city in the event of its being desired to take the supply out of the Humber. The first would be to obtain power to purchase out all mills below the point of abstraction. It is doubtful if such a power would be granted if opposed by the mill owners, as it most certainly would be, inasmuch as no plea of strong necessity could be urged so long as the city has the lake to resort to for water. But if a compulsory power were granted, it would only be upon conditions of indemnity wholly favorable to the proprietors; the prospective damages would, in all probability, deter the corporation from taking any action in the matter. To divert the waters of the Humber so as to annihilate the water power upon it in

the Township of York would be very questionable policy, even if it were in the power of the city to take this course; money might compensate the proprietors of the mills, but there would be no redress for the population of the villages and hamlets erected by each water fall; and the severity of such a course, would be only equalled by the impolicy of thereby destroying almost suburban customers.

The second course would be to give compensation in water to the mills below, for the portion abstracted from the river, by extensive storage Reservoirs for floods upon different portions of the stream. This is an alternative which, independently of the cost, would require years for the arrangement of the preliminaries. The privilege of abstracting flood or surplus waters from mill streams would only be granted upon conditions imposed by the Legislature. Although the mills do not and cannot use one half of the whole quantity which annually flows down, yet the miller's proportion is a quantity which has never been clearly defined. The usual course is to guage the stream by some third party named in the Act, for a series of years, and when the average flow is thus ascertained, the quantity which may be taken is defined.

The ordinary flow of these streams appears to yield decidedly harder water than that of Lake Ontario; and, from the nature of the country drained, the water is frequently disturbed to such an extent as to be unfit for domestic purposes.

Gravitation supplies are seldom sought for or obtained in rich aggricultural districts. In primitive formations, mountainous, rocky, and uncultivated regions, such as those from which the cities of New York, Boston, and Quebec draw their gravitation supplies, a pure, clear, and soft water is obtained; but from such streams as the Don and Humber, neither the turbid water of the floods, nor the clear but hard yield of the low-water flow from springs, will afford a satisfactory supply for domestic or manufacturing purposes. The main obstacle to a gravitation supply for Toronto is the fertility of the surrounding country,—a circumstance which not only can be no matter of regret, but which gives assurance of the ability of the city to adopt any other system which may prove more desirable.

With respect to a gravitation supply from more distant sources, such as Bond Lake or Lake Simcoe, it may be said that the distance in either case, would make the cost greater than pumping; while

in the case of the first there is a want of water, and of the second there is no practicable means of obtaining it.

Bond Lake is a small pond without any visible outlet, upon the dividing ridge or summit, about twenty-one miles from the city; the drainage area being so limited that the losses by evaporation and filtration are sufficient to dispose of the rain fall supply.

Lake Simcoe, besides being over thirty miles distant, lies over one hundred and fifty feet lower than the intervening ridges which separate it from Toronto,—a fact which precludes all idea of obtaining a supply from that source, as its waters could only be abstracted by a cutting several miles in length.

In short, the uncertainty (in consequence of Legislative difficulties,) as to the time within which it would be possible to carry out any gravitation scheme, as well as to the cost of the same, by reason of the indemnities to be paid, would be of themselves sufficient reason for abandoning that mode of supply, in the case of Toronto, without reference to the more positive disadvantages of the system. It would, in all probability, prove the most expensive and the least satisfactory mode which could be adopted.

In consequence of the foregoing considerations, I did not feel warranted in going to the expense of the elaborate surveys required in order to shew all the features of a gravitation plan. The main facts, as bearing upon the practicability of the plan, in the case of both the Don and Humber, have, however, been ascertained; and a statement of the mill properties which would be interfered with, is appended to this report.

## PUMPING FROM LAKE ONTARIO.

Toronto Harbour or Bay, as the receptacle of the sewage water of the city, (which is annually increasing in quantity and impurity,) the offal from the shipping, and the turbid discharges of the Don, affords no covenient point from which an unexceptionable supply can be obtained.

The Don Marshes, and Ashbridge's Bay with its extensive marshy borders, cut off the main shore from the Peninsula, and both from this cause, as well as from the absence of sufficiently high reservoir ground opposite them, it will be necessary, in seeking a pumping station to the eastward, to go as far as the junction of the peninsula with the main land. This is opposite the junction of the Kingston

road with the one leading to Dawes' tavern, a distance of four miles from the City Hall.

In the opposite direction the most eligible site would be at the western limit of the city, that being upon the most southern point of land projecting into the Lake, nearly mid-way between the Humber Bay and Toronto Harbour, and distant from the City Hall about three miles.

Between these extreme points, which are seven miles apart upon an east and west line, there is yet to be noticed the Peninsula itself, separated from the city and the main shore by Toronto and Ashbridge's Bay and the Don Marshes. It has been proposed to obtain a supply from the Lake outside this Peninsula, and conduct it across the Bay by a submerged pipe. It is not probable that water, which would be less disturbed by storms, would be obtained outside of the Peninsula, than can be had off the eastern or western points I have alluded to, but it is highly probable that by forming a basin upon the "Island," filtered water could be obtained. Taking the width and depth of the Bay into consideration, the laying and maintaining of a submerged pipe across it would be a work of great difficulty, expense, and hazard. An important section of the work would be inaccessible in case of accident to the submerged pipe, and if this in time became wholly or partially choked up by deposit, the length and size of the main would be such, that "blowing off," as a means of removing the silt, could not be depended upon. Moreover, the whole length of large pipe to reach a reservoir upon the Davenport ridge, with a returning supply main to the centre of distribution, would be greater than for either of the other plans,—and this could only be avoided by the objectionable course of pumping directly into the distribution. If the engine-house could be placed upon the peninsula, the best course would be to lay the pipe above high-water level, and force the water around the head of the Bay. The Peninsula is, however, too much exposed to the inroads of the Lake to afford eligible sites for the pumping engines at any convenient point; and a pumping main across the marsh opposite the Don, would be a barrier to any future communication with Ashbridge's Bay. The length of pipe necessary to reach any suitable reservoir site, as well as the circuitousness of the route, would neutralise the advantages such a station might otherwise possess.

## RESERVOIRS.

In close connection with the selection of the pumping station, is the consideration of the level upon which the Reservoir should be placed.

Toronto is situated upon a slope, rising from 15 or 20 feet at the Bay to 130 feet at Yorkville, its present and northern limit. Northward of this limit the regular ascent is checked, and there is a large extent of table land, about the same elevation as Yorkville, extending to the base of the Davenport ridge. As this district will at no very distant day be embraced within the city limits, it is important that the reservoirs should be placed so as to give an efficient service to the whole area between the base of this ridge and the city proper.

For the western pumping station there is no nearer eligible reservoir site than one immediately below the Davenport Road, which will involve a pumping main over three miles in length, and a supply main, following the northern city limit to Yorkville and thence to the intersection of King and Yonge Streets, over five miles long. For the eastern station a pumping main a little more than one mile, and a supply main of 4½ miles, would reach the intersection of Queen and Yonge Streets—but the position of this supply main would be less favourable than the other.

The western mains would lie upon a high level, thus reducing the pressure upon them, and diminishing the thickness of metal required, while the eastern one, from the foot of the hill upon the Kingston Road to Yonge Street, would be under the heaviest pressure.

A more important advantage of the higher position of the western mains is the increased efficiency which would be afforded to the distribution in those districts where of necessity the pressure will be least. More than half of the whole daily consumption of a city is drawn in less than six hours: while this is going on the mains are taxed to their full capacity, and the pressure of the reservoir is reduced; the greatest consumption taking place south of Queen Street, the water from the high level pipes would settle away towards the points of greatest draught in the lower districts, thus reducing the pressure, and possibly at times emptying the high level pipes.

The water level of the western reservoir, as well as that of an eastern one, south of the Kingston Road, would be, when full, 178 feet above the lake. By extending the eastern pumping main 1000 feet across the Kingston Road, making its whole length 5400 feet,

another and more extensive site, 22 feet higher, or 200 feet water level above Ontario, can be obtained, upon the "Norway Ridge," on the south side of the Grand Trunk Railway. The supply main of a reservoir upon this ridge could follow the line of the Don and Danforth Road to the Todmorden toll-gate, and enter the city at a high level. The passage of the Don by this route is unfavourable, and the whole route longer and more circuitous than the direct one by the Kingston Road and Queen Street.

The level of 178 feet above the lake is sufficient, with a proper system of distribution, to insure an effective service to all points southward of the Davenport ridge, and, as the water is to be pumped, it would be injudicious to increase the additional annual cost of lifting the whole supply above this level—which not only provides for all purposes of domestic consumption in the highest districts, but affords an effective fire pressure upon the greater portion of the city, including all the commercial streets.

The sites for the eastern reservoirs are in sand and gravel, which will not hold water without a proper lining or puddling, the expense of which will have a natural tendency to diminish their area. This is not the case at the western site, where the soil is clay and sufficiently retentive—but the difference in the value of land will go far to equalize the two sites in point of total cost.

The dimensions of the reservoirs for the two sites will not necessarily be the same to produce the same efficiency, if the water can be obtained in better order at one point than at the other. At the western pumping station there is no opportunity for obtaining water naturally filtered, and it will be necessary to construct either a pumping basin, from which the lake can be excluded when too much disturbed, or to make the distributing reservoirs of such dimensions as will render it unnecessary to pump during such disturbance. The latter course is the preferable one, because there is an unlimited extent of favourable ground for the construction of distributing reservoirs; and the additional advantage of improving the water by subsidence in a large reservoir would be obtained. Moreover, the very great advantage of having a large body of water in reserve would be secured, which is one of the most important considerations in connection with a supply which is dependent upon machinery.

A depth of twenty feet is obtained at about 330 yards from the shore, at the western station, and by drawing from this depth and

distance it is believed there would not be, with reservoirs of sufficient capacity, any inconvenient interruption to pumping arising from the condition of the lake. To determine this point, however, a register of the condition of the water should be kept, for which there is sufficient time before a selection of the pumping station is necessary. Under any circumstances, by means either of a pumping basin or of duplicate reservoirs, (one as a receiving one for the water, if disturbed, and the other as a distributing one for it after subsidence), the difficulty can be met.

The material held in suspension at this point is argillaceous; the same wear of pump valves, therefore, would not take place here as at points where the beach is sand.

At the eastern station there is a fine gravel beach, upon the main shore, which connects with the bar of sand and gravel forming the commencement of the Peninsula and dividing it from the marshes at the head of Ashbridge's Bay. In storms the lake breaks over this bar into the marshes. On the main land the shore is composed of an earthy sand, not sufficiently porous to admit the passage of the lake water through it, but as the ground is low there does not appear to be any obstacle to the formation of a pumping basin, or reservoir, to be supplied by filtration from the lake.

It may be necessary to resort to the bar referred to (which is the root of the Peninsula) for this purpose, in which case the basin must be protected from the inroads of the lake, and the water from the filter basin be conducted to a suitable site for the engine.

With water obtained in the manner described, which can be tested upon a larger scale than I have felt warranted in doing, its condition would be similar at all times, and with reserve engine power large reservoirs, though highly desirable in connection with all pumping plans, would not be so necessary as in the western plan.

There is, however, an important advantage in the position of the western reservoir, in that the city is evidently growing *towards* it and *from* the eastern one. This may be overcome hereafter by an additional reservoir under the Davenport ridge, at the extension of Spadina Avenue, or of Bathurst Street, to be fed from the eastern one. In consequence of the greater distance of the eastern reservoir from the future centre of distribution, the elevation of 200 feet for the water surface, or 22 feet higher than the western one, should be

selected, which level is afforded by the ground between the Kingston Road and the Grand Trunk Railway.

## PROTECTION AGAINST FIRE.

It has been already stated that the districts at and northward of the northern limit of the city (which are 125 feet and over above the lake) would require for domestic purposes a water level of 178 feet in the distributing reservoirs, to obtain which it is necessary to resort either to the foot of the Davenport ridge, or to the Scarboro' heights. The top of the Davenport ridge is 250 feet above the lake; the cost of the pumping to this height would be very much increased without proportionate gain. The ridge rises so abruptly that there is no favourable intermediate point: either the base or the summit of this ridge must be selected.

Looking to the expense of pipeage arising from the necessary distance of either reservoir site from the heart of the city, it may be urged upon considerations of economy, that a reservoir at Yorkville, at the head of Sherburne Street, would meet present wants. This proposition would have greater force if an eligible pumping station could be obtained opposite the occupied portion of the city.

The cities of New York, Boston, Philadelphia, and almost all American towns are supplied from reservoirs not more elevated than Yorkville. This has been more a matter of necessity than choice, as in each case the highest available ground has been occupied. In Quebec and Montreal the pipes are under a higher pressure, and the important object gained thereby is the early, easy, and rapid extinction of fires, wherever the hose can be put in direct communication with the mains. It is but recently that this object has been sought for in the supply of water to towns, and I cannot lay it before the city authorities in a better manner than by quoting from a paper read by Mr. Braidwood, Superintendent of the London Fire Brigade, before the Society of Arts about a year since. Mr. Braidwood says:

"From 1838 to 1843 £776,762 were lost in Liverpool by fire, almost entirely in the warehouse risks. The consequence was that the mercantile rates of insurance gradually rose from about 8*s.* per cent. to 30*s.*, 40*s.*, and it is said in some cases to 45*s.* per cent. Such premiums could not be paid on wholesale transactions, therefore the Liverpool people themselves obtained an Act of Parliament, 6 & 7 Vic., Chap. 109, by which the size and height of warehouses

were restricted; party walls were made imperative, and warehouses were not allowed to be erected within 36 feet of any other warehouse, unless the whole of the doors and window-shutters were made of wrought-iron, with many similar restrictions. This Act applied to Warehouses already built, as well as to those to be built; and any tenant was at liberty, after notice to his Landlord, to alter his warehouse according to the Act, and to stop his rent until the expense was paid. Another Act, 6 & 7 Vic., chap. 75, was also obtained, for bringing water into Liverpool for the purpose of extinguishing fires, and watering the streets only. It is supposed that the works directed, or permitted by these two Acts, cost the people of Liverpool from £200,000 to £300,000. Shortly after these alterations had been made the mercantile premiums again fell to about 8s. 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; but to enable us to follow this system, the whole water supply of London would require to be remodelled.

"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. In London, however, that can rarely be done, for several reasons. The greatest number of plugs are on the service pipes, that is, the pipes for supplying water for domestic and other purposes, which are only open a short time every day. If the cisterns are nearly empty, the pressure cannot be obtained till they are filled. Then, again, the plugs being some distance apart, it is difficult to obtain a sufficient number of jets. But when the plugs are full open 1¾ inches in diameter, a sufficient quantity of water is obtained from each to supply three engines, each of which will give a jet equal to the plug, if confined to one jet. The pressure, also, in the mains in London seldom exceeds 120 feet at the utmost. For these reasons, the pressure from the mains is seldom used till the fire is checked, when the ruins are cooled by the "dummies," as the jets from the mains are called by the firemen.

"London is, upon the whole (except in the Warehouse districts), fairly supplied with water for the average description of fires, that is,

where not more than five or six engines are required. When, however, it is necessary to work ten or twelve engines, there is very often a deficiency. In New Cannon Street, where some of the largest warehouses have lately been built, except at the crossings of the old streets, there is only a 4½ inch service pipe. In other warehouse districts the supply is very limited indeed, although it is amongst the warehouses that the largest fires takes place.

"The Water Companies are generally willing to give any quantity of water, but they object to lay down mains without any prospect of remuneration. The warehouse keepers decline to be at the expense of laying the pipes, and there the matter seems to rest. In most other places of importance the water is under the management of the civic authorities, and they, of course, endeavour to obtain a good supply of water in warehouse, as well as in other districts."

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 conveyed to the stations of the brigade at a rate of five miles an hour. In the case of the occurrence of a fire within a mile of the station, the information would be conveyed in twelve minutes, the horses would be put to, and engines got out in about five minutes, on the average; it traversed 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 too 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 concurrence 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 mean of a hose and jet. By that arrangement 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 would be effectually arrested. Mr. Wm. Lindley, the Engineer, who had rebuilt 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) sanitary 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 annum."

"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 pipeage 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 are 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."

In an article on fire administration and fire police, published at the same time, Mr. Hyde Clarke, C.E., speaking of London says :—

"The supply of water for fires and the distribution of it are equally defective. One of the first functionaries needful for a fire is the turncock, as it is seldom the police or the firemen can get at a main having a constant supply. The most efficacious measure for coping with fire is a constant supply of water as is attained in so many of the large towns in England, whereas the Metropolis is given over to the water monopolists, who work the water supply for their own purposes on the cistern system. Thus no house or building has within it communication with a constant supply of water, and so far from it, a scheme of tricking is devised for restricting the supply of the inhabitants within the narrowest limits. Thus, unless when the municipal authorities and boards of health intervene, there is no water supply on the Sunday—a day on which much water is used for cooking by the working classes, and the inconveniences are very great. Another trick is to turn on water at seven o'clock in the morning and stop it at eight, at a time when most of the population and the servants are busy with preparations for breakfast. The working classes are thus kept, without a further supply of water than their small cisterns hold, from eight on Saturday morning to the like hour on Monday; and then the supply, by way of change, is sometimes deferred till eleven. Besides other domestic inconveniences inflicted on the poor, the annoyance from the deficiency as affecting water closets may be anticipated."

"As this system of trickery is resorted to for house supply, of course it governs the fire supply, although the water companies do profess to supply the Metropolis gratuitously with water for fires. The consequence is a needlessly complicated system of fire mains, plugs, turncocks, and tools, which come together at the moment when speed is

of vital importance, to mar the efforts of the fire brigade who ought not to have any trouble.

"One thing necessary is a liberal supply of stand cocks, as in some cities, to which hose could be applied in the greater part of the metropolis and throw a jet at once. All public and private buildings should be allowed to supply themselves with uniform stand cocks and hose, and hose should be kept at the police stations. Except in the higher parts of the metropolis where adequate pressure cannot be got, a greater power of instantly coping with fire would be attained."

The City of London is supplied by numerous competing water companies, and in consequence of the many complaints, great efforts were made for years to place the supply in the hands of the corporation. The combined influence of the water companies was, however, too powerful in the House of Commons; but the result of years of contest was that Parliament, by the Water Works Clauses Act in 1847, drove the companies out of the city for a purer supply, and compelled them in a great measure to re-construct their works.

Liverpool and Manchester purchased out the old water companies, abandoned their old works and constructed entirely new ones, with special reference to the fire question. Glasgow has recently bought out both the Glasgow Pumping and the Gorbal's Gravitation Works, and has gone off to Loch Katrine, a distance of 35 miles, to bring in a more abundant and purer supply at an additional outlay of about £900,000. It is probable that in every city where it is practicable, steps will be taken sooner or later to obtain a fire pressure, and as far as possible to dispense with the use of engines. It is evident from the quotations above made, that in London this system would be adopted if the corporation possessed the works, but it can hardly be expected that the water companies, looking to the largest returns for their investment, would lay down the mains and hydrants on such a scale, and provide the liberal supply of water required for the public protection, or for the public health, in street washing, fountains, &c. &c. Such considerations induced Liverpool, Glasgow and Manchester, the next largest cities to London, where the water companies were neither so numerous nor powerful, to take the supply into their own hands. In the case of Manchester, the corporation owns the gas as well as the water works.

## ESTIMATE OF COST.

To establish a fair comparison between the Eastern and Western plans, the provision for the pumping stations and reservoirs is alike for both, the cost of the wharf and conduit at the west end being applied to the construction of a filtering basin at the east. The difference of cost is chiefly in the length of the larger pipe, but to compare the eastern supply main fairly with the western one, the former is carried as far as York street, making its length equal with the latter. The only important difference in the cost of this main, is made by the bridge for the passage of the pipes over the Don.

Although the eastern reservoir is 22 feet higher, the pumping main is only one-third the length of the western one; the difference in the lift is not therefore important, but in the annual expenses, there will be an additional charge for extra cartage of coal and stores, unless a landing wharf is constructed at the eastern station.

To deliver an average supply of four millions of gallons for one hundred thousand inhabitants, will cost in coal, labour, stores, wear and tear, about £6,250; but this will not be attained until the population has reached that point, and until the proportion of manufacturing and other large consuming establishments brings the consumption up to the rate estimated. For the full supply of the city in 1860, the annual cost would not exceed £3,500.

The provision for engine power, the size of mains and reservoirs, are for a population of 100,000. The distribution is provided,—with hydrants, &c., according to the plan,—for all principal streets. The extent of pipeage provided would probably supply a population of 100,000, if the whole of the streets were closely built up, but as in practice this will not take place, and new streets will be annually opened, about 25 per cent. addition to the distributing pipes would be called for before the prescribed population is reached.

The engine power required for the full supply, is about 200 horse, working constantly. Three engines of 100 horse power each are provided in a building constructed for four. The pumping and leading mains are 24 inches diameter, and the latter is over 5 miles long.

I have submitted the estimate for the scale proposed, but as the great merit of pumping schemes, as compared with gravitation ones, is that they are capable of successive enlargement, and as it is mani-

fest that a considerable period will elapse before the population reaches 100,000, it would not be prudent or necessary to carry out the works upon that scale, except in such portions as cannot be conveniently enlarged, or where the difference would be unimportant.

By erecting only two engines, which will supply the wants of the city for some years, about £15,000 upon the engines and buildings will be saved.

The pumping mains should not be reduced, but on account of the great length of the supply main, it would be sufficient now to lay one of 18 inches diameter, which would supply present wants, and a duplicate one hereafter. This plan will give greater security in case of an accident upon this long line of main, and will save an immediate outlay of nearly £17,000.

In the matter of reservoirs, a reduction from the scale of 100,000 inhabitants can be effected, as this is a section of the work to which additions can at any time be made. If filtered water can be had, the present expense of the eastern reservoir may be diminished £10,000.

For the item of distribution the very large sum of £100,000, is provided. The usual estimate for this service is 25s. per head of the population, and for the present wants of the city, £75,000 would be a very liberal provision. This is an item which is susceptible of addition or reduction, and there can be no difficulty in keeping within the prescribed expenditure by fixing the extent of streets first to be supplied.

The sum of these deductions will be £67,000, an amount which can for the present be left out of the estimate for the population of 100,000, without injuring the efficiency of the works.

## NO I.—TORONTO WATER WORKS.

*Estimate for Western Plan, upon the Scale of* 100,000 *Inhabitants, except for Distributing Pipes.*

| | | |
|---|---|---|
| Pumping station, including land, wharfing, &c..... | | £12,500 |
| Engine house and foundations, boiler house, coal sheds &c., | | 10,000 |
| Three expansive engines, 100 horse power each, with pumps and connections..... | | 39,000 |
| Pumping main, 5760 yards long, 24 inches diameter, including valves, &c ..... | | 33,000 |
| Supply do. 9,000 do. do..... | | 51,000 |
| Distributing reservoirs including land, ten acres water surface, contents 60 millions of gallons..... | | 20,000 |
| Distributing pipes 40 miles, including valves and hydrants, | | 100,000 |
| | | 265,500 |
| Superintendence and contingencies..... ..... | | 25,000 |
| | | 290,500 |

*Deductions from above Estimate until the Population exceeds* 60,000 *Inhabitants:—*

| | | |
|---|---|---|
| On engine house and engines ..... | £15,000 | |
| On supply main ..... ..... | 17,000 | |
| On reservoir ..... ..... | 10,000 | |
| On distribution ..... .... | 25,000 | |
| | | 67,000 |
| | | £223,500 |

## NO. 2.—TORONTO WATER WORKS.

*Estimate for Eastern Plan, upon the Scale of* 100,000 *Inhabitants, except for Distributing Pipes.*

| | | |
|---|---|---|
| Pumping station, including land and pumping basin..... | £ | 12,500 |
| Engine-house and foundations, boiler-house, coal-shed, &c. | | 10,000 |
| Three expansive engines, 100 horse-power each, with pumps and connections..... | | 39,000 |
| Pumping main 24 inches diameter, 1,800 yards long, including valves..... | | 11,000 |
| Supply, do. 9,000 do. do. do..... | | 54,000 |
| Pipe-bridge over the Don, with approaches..... | | 5,000 |
| Distributing reservoir, including land, ten acres water surface, contents 60 million gallons ..... ..... | | 22,500 |
| Distributing pipes, 40 miles, including valves and hydrants | | 100,000 |
| | | £254,000 |
| Superintendence and contingencies..... | | 25,000 |
| | | £279,000 |

*Deductions from above Estimate until the Population exceeds* 60,000 *Inhabitants* :—

| | | |
|---|---|---|
| On engine-house and engines..... | £15,000 | |
| On supply main..... ..... | 17,000 | |
| On reservoirs..... | 10,000 | |
| On distribution..... | 25,000 | |
| | | £67,000 |
| | | £212,000 |

## ESTIMATE OF REVENUE.

The supply of water to a city differs from most other municipal expenditures—in that it is a source of direct revenue, as well as of great public benefit.

Although New York has spent $18,000,000, and Boston $5,000,000 for water, no complaint of the cost is ever heard; nor would ten times the sum expended, induce the citizens to part with the works. Expenditures for drainage, grading, and paving, as well as for the maintenance of order, although essential to the well being of every city, are not productive of a direct return; but the charge for water is as certain, and as cheerfully paid as that for gas. This is so well understood by capitalists, that water works debentures (which have, besides the city guarantee, the additional security of a first lien on the revenues from the works,) rank higher than the ordinary municipal debentures of the same city.

The advantages to be derived from improved cleanliness in streets, dwellings, &c., and the corresponding improvement in the health, comfort, and habits of the population, are not susceptible of any pecuniary estimate, although they are among the most important which the works will produce.

The additional value given to city property, although a positive pecuniary item in the estimate, would be too conjectural to take into account. A house with every room supplied with water and gas, will command a higher rental than a similar one without these advantages; and a city with an efficient water supply, will be a safer warehouse for the wholesale merchant or manufacturer, and a more attractive residence for the wealthy immigrant, than one in which this great work is unsupplied, or upon an inefficient scale.

Besides the annoyance created by dust, the injury done by it to furniture, at a season of the year, when doors and windows are necessarily left open, as well as the damage to dry goods, &c., exposed for sale, are serious items, of which there is no means of forming an estimate.

Works of this description, are not expected to yield a revenue equal to the interest upon their cost, for a number of years after their completion. Until this period is reached, the deficiency must be provided for; this, however, should be charged to the public account, for street watering, and protection against fire.

The rates are usually fixed low, with reference to a future population, and they are frequently lowered as the revenues increase, both for the purpose of encouraging the most extended use of the water by the population, as well as to relieve consumers from the burden of the whole of the interest, while the city is deriving so large benefits in the supply for streets and fires.

The revenue from the Croton works, in 1855, was $674,736, the ratio of increase being 10 per cent. per annum; that of the Philadelphia works, was $330,000; and that of the Boston, $259,750. The Philadelphia works, which cost about $3,000,000, have paid for themselves long since; and it is certain that the full amount of the interest upon the cost of the works in Boston and New York, could be at once obtained without difficulty, if necessary.

The items of direct revenue are, the water rents, the reduction of expenses in the fire brigade, and the saving of that for street watering. The proportion of water tenants to the whole population, is pretty well established at about one in every eight, and agrees very closely with the number of houses in the city in proportion to the census. In all probability, before the works can be put in operation, there will be fully 7,500 houses within the city limits, two-thirds of which, or 5,000, may be supposed to be within the reach of the water pipes: upon these an average rate of £3 may be estimated.

In addition to these ordinary rates, there would be special ones for extra baths, and water-closets, bakeries, breweries, slaughter-houses, livery stables, hotels, saloons, printing offices, steam engines, railroad stations, locomotives, &c., &c, which should amount to at least £5,000, although it may be three to five years before this amount is reached.

For watering portions of nine streets only, the city paid last year the sum of £1,355, an item which will be annually increasing; and which, if extended all over the city, at the same rate, would go far towards paying the interest on the cost of the works.

We may safely assume £1,500 as the annual value of this service in 1860, when the new water works may be supposed to be in full operation. The cost of watering streets, in the damper climate of London, is about £75 per mile per annum. The distribution pipe estimated would water forty miles of streets, instead of the limited portions now provided for.

The expenses of the fire department, in 1856, were £4,765. With

the proposed system of supply, fire engines, except in the suburbs, will be to a great extent dispensed with, and we may fairly estimate a saving of £3,000 upon the expenses of this department for 1860. Besides the above, the city pays for the water supplied to some half-dozen markets and public buildings.

We have then of direct revenue :—

| | | | |
|---|---|---|---|
| Water rents, | 5,000 tenants at £3 ..... | £15,000 | |
| | Special rates ..... | 5,000 | |
| | | | £20,000 |
| Amount saved in watering streets..... ..... | | | 1,500 |
| " " in fire department expenditure,..... | | | 3,000 |
| | | Total, ..... | £24,500 |

Which would be about six per cent. upon the estimated cost of the works, after paying the annual cost of working them—although there would be an apparent deficiency of £4,500, the amount charged to street watering and fire department.

It may be urged that the whole amount, of ordinary and special rates, will not be obtained in 1860; but it must be admitted that an average exceeding £3 may be laid on, as an ordinary rate, (which is considerably below the charge of the existing water company, for an inferior supply,) instead of the £3 estimated. It may be also objected, that street watering from the hydrants, will still be attended with some expense; but this will certainly not exceed the water rates, paid by the city for public buildings, of which no account has been taken in the estimate.

If the ordinary rate be taken at £2 10s., which is less than is now charged upon the gravitation supply of Boston, and the estimate of special rates be reduced one-half, the revenue account would stand thus :—

| | | |
|---|---|---|
| 5,000 tenants at £2 10s..... ..... | £12,500 | |
| Special rates,..... ..... | 2,500 | |
| Amount saved in fire department and street watering, ..... | 4,500 | |
| | | £19,500 |
| Interest at 6 per cent upon £225,000 the highest amount now required would be ..... | £13,500 | |
| The annual cost of pumping ..... | 3,500 | |
| | | £17,000 |
| Leaving for salaries and management per annum... | | £2,500 |

It must, however, be borne in mind that there will be an item of interest and discount upon debentures, (the amount of which will depend upon the duration of the period of construction and the value of the city securities) which will increase the estimate of cost, and unless provided for out of revenue, will form part of the debt upon which the future interest must be paid.

In New York and Boston, the proportion of the special or extra rates is much larger than I have assumed in the above estimate, being from one third to one fourth of the whole revenue.

The foregoing estimate is based upon the population in 1860 only, the period when it is supposed the works would be in operation; the scale of the works being for a population of 100,000, the increase in revenue, after 1860, must be much greater in proportion to the expenditure after that date.

The estimate provides for nearly 40 miles of distributing pipe which will supply double the number of tenants estimated for 1860. The average number of tenants to every 100 feet of distributing pipe in Philadelphia is five, while the provision of pipes for Toronto exceeds 200,000 feet, for only 5,000 tenants, or 2½ tenants per 100 feet.

No notice as yet been taken of an important, and direct pecuniary advantage, to be derived from the construction of the works as proposed, viz. :—a reduction in the rates of insurance. Upon this point I prefer to quote from the report of the Jersey City Water Commissioners, who have recently erected most efficient pumping works, at a cost of £180,000, for a population about the same as that of Hamilton.

"It appears that upon first class buildings, 15 cents per $100 more is charged in Jersey City than in New York; and on buildings of the seventh class, the difference amounts to 50 cents per $100. As a pretty large proportion of the buildings, in Hoboken and Jersey City are of wood, and belong to those classes which are charged at the highest rates, it is believed that the extra charge, which would be made for insuring the whole of the property, liable to be destroyed by fire, situated within their limits, would be at least 33⅓ cents per $100 or one third of one per cent upon the value. If the assessors valuation of the property, be taken as a basis for calulation, and to that be added the value of public buildings not taxed, railroad property, ferry boats, and other vessels in port, and other property which escapes the assessors search, and from this amount be deducted the value of the land, the remainder will be the value of that which will be protected by a full supply of water. An *accurate* estimate of this is at present impracticable, but it is believed that $6,000,000 is a low, rather than a high valuation, and if one third of one per cent of its value can be saved in the price of insurance it will amount to $20,000 per annum."

"This increased security is a consideration which affects every individual citizen, both in person and property. It makes no difference with the latter whether he pays an office for insuring him, or whether he runs his own risk,—it is equally an item of charge against the property; and many a valuable life would be saved, if an abundant supply of water were always at hand in cases of fire, and ready for immediate use.

"With respect to the value of the Croton Water in preserving property from destruction by fire, the Croton Aqueduct Board, in a report made in 1845, said, 'One fact, susceptible of the fullest demonstration, needs to be mentioned,—it is, that every person who pays tax on real or personal estate, actually pays less money now than he did previous to the introduction of the water. This arises from the reduction of the rates of insurance. The tax to defray the interest in the Croton Water debt is twenty cents per hundred dollars. And the average rate of reduction in the rates of insurance is forty cents on the hundred dollars.' And in a subsequent report it is repeated that the owners of property are actually paying less money than they would be obliged to pay were the Croton Water not brought into the city, for the following reasons:—First, allowing, for

the sake of argument, that the rates of insurance are the same now as previous to the introduction of the water, the frequency of fire must have increased them at least fifty per cent., if we were destitute of the abundant means to stay its ravages which the city now possesses.

"Again, the expenses of the fire department, which, previous to the advent of the Croton Water, had increased to near 70,000 dollars per annum, and, in progressive ratio, at this day would undoubtedly have exceeded 100,000 dollars—have, since that event, decreased yearly; the appropriation asked for the current year will be considerably less, as the Board are informed."

The foregoing report was written in 1852, before the commencement of the works; in the report of the Commissioners for June, 1855, less than one year after the opening of the works, I find the following paragraph:—

"The preservation of property from fire by these works of the city, has been the cause of a reduction of the premium asked by the Insurance Companies; and the Companies in New York have already placed the property here at the same standard with that of the same classes in New York, which before the introduction of the Passaic water was much higher."

## CONCLUSION.

It will be seen from the foregoing report, that as between the eastern and western plans, which are similar in principle, there are no such decided advantages, either in the natural features, or in the probable cost, as would make the selection obvious. Either plan, in my judgment, will afford an efficient supply, and this consideration reduces the importance of the selection.

The western plan affords a more eligible site and foundations for the engine-house, a more retentive soil for the distributing reservoirs, and a better position for the mains; it also places the stored waters, in the line of the City's march, and *westward* of the Don, beyond the risk of any important interruption to the supply between the reservoirs and the town, as would be within the limits of probability if the passage of the Don be necessary.

The eastern plan has the advantage of a shorter pumping main and a somewhat higher elevation for the reservoirs, (which latter would be in the best position for maintaining the purity of the water,) a clean gravel beach, and a possibility at least of affording filtered water. In the estimate, provision is made for obtaining the water at the eastern station in the same manner as at the western one, in case a filtering basin should be found impracticable. If this basin is obtained, there would not only be the advantage of the superior quality of the water itself, but as there would be no necessity for any subsidence, the size of the Reservoirs may, for purposes of economy, be diminished.

The condition of the water to be obtained at the respective points is, therefore, the most important consideration,—as any decided difference in this respect would outweigh the other preferences of each plan. During the winter the bordage-ice protected the shore from the wash of the waves, and since the departure of this glacial fringe, all that has been observed is,—that with light easterly winds the water is most disturbed at the eastern station, and with a similar westerly wind the disturbance is greatest at the western station; and that, after a blow, it clears more rapidly at the east than at the west.

There will probably be some exceptions taken to the western station, as liable to be influenced by the discharges of Toronto and

Humber Bays. Although I consider this station out of the reach of any objectionable influences, I am aware of the difficulty of dealing with so subtle and delicate a question, if prejudices exist, especially where, as in the present case, there is another eligible station, to which such objections cannot be raised.

Some time must elapse before the works can be commenced, and as it is not necessary that the pumping station should be selected until a considerable portion of the pipes (which must be imported) arrive—I would recommend that steps be taken for observing, in the interval, the condition of the water at the respective stations, and also, that experiments be made upon a sufficient scale to determine the practicability of a filtering basin at the eastern station. The selection should depend upon the result of these observations; and as I consider these are the only two eligible points from which a satisfactory and efficient supply can be obtained, and believe that either of them will meet all requirements, I have not thought it necessary to withhold this report, for the purpose of more extended examinations.

I have the honour to be,

SIR,

Your obedient Servant,

THOS. C. KEEFER.

TABLE *of Mills and Machinery upon the West and North Branches of the River Don, below the level of* 200 *feet above Lake Ontaria.*

| | Description of Mill. | Proportion of Time worked in the Year. | Machinery. | Machinery worked at Lowest Water. | Work done per hour by each Piece of Machinery. | Head and Fall. | Names of the present Proprietors. |
|---|---|---|---|---|---|---|---|
| West Don. | Grist Mill. | 12 months. | 2 run of stones. | 1 run of stones. | 8 bushels ℔ run. | 12·00 | Taylor Brothers. |
| | Paper " | do. | | | | 12·00 | do. |
| | Do. " | do. | | | | 16·00 | do. |
| | Do. " | do. | | | | 24·00 | do. |
| | Saw " | 9 months. | 1 upright saw. | All. | 126 ft. B.M. | 24·00 | do. |
| | Do. " | do. | 1 do. | " | | | J. Snider. |
| | Do. " | do. | 1 do. | " | | | B. Holmes. |
| | Do. " | do. | 1 do. | " | | | J. Burke. |
| | Do. " | do. | 1 do. | " | | 9·00 | R. Jones. |
| | Do. " | do. | 1 do. | " | 130 ft. B.M. | 7·00 | T. Lawrence. |
| | Do. " | do. | 1 do. | " | 170 ft. B.M. | 9·00 | E. Easton. |
| | Grist " | 12 months. | 2 run of stones. | 1 run of stones. | 5 bushels ℔ run. | | L. Moffatt. |
| | Do. " | do. | 3 do. | Mill not completed. | | 12·00 | J. & W. Hogg. |
| North Don. | Saw Mill. | 8 months. | 1 upright saw. | All. | 125 ft. B.M. | 11·00 | Milnes. |
| | Woolen " | 10 do. | | " | | 11·00 | do. |
| | Saw " | 4 do. | 1 upright saw. | None. | | 8·00 | W. Grey. |
| | Grist " | 9 do. | 2 run of stones. | 1 run of stones. | 4½ bushels ℔ run. | 8·00 | do. |
| | Saw " | 7 do. | 1 upright saw. | All. | 125 ft. B.M. | 7·00 | J. Hunter. |
| | Grist " | 12 do. | 2 run of stones. | 1 run of stones. | 9 bushels ℔ run. | 12·60 | T. Sheppard. |
| | Saw " | 3 do. | 1 upright saw. | None. | | 10·00 | do. |
| | Do. " | 12 do. | 1 do. | All. | 176 ft. B.M. | 7·00 | H. Johnston. |
| | Do. " | 9 do. | 1 do. | " | 170 ft. B.M. | 10·00 | J. Coomers. |

TABLE *of Mills and Machinery upon the River Humber below the level of* 200 *feet above Lake Ontario.*

| Description of Mill. | Proportion of Time worked in the Year. | Machinery. | Machinery worked at Lowest Water. | Work done per hour by each Piece of Machinery. | Head and Fall. | Names of the present Proprietors. |
|---|---|---|---|---|---|---|
| Grist Mill. | 12 months. | 6 run of stones. | 2 run of stones. | 8 bushels ℔ run. | 20·00 | W. Gamble. |
| Saw " | 9 " | 1 upright saw. | All. | 3000 ft. B.N. ℔ day. | 20·00 | do. |
| Grist " | 12 " | 3 run of stones. | 1½ run of stones. | 7 bushels ℔ run. | 15·00 | T. Fisher. |
| Do. " | 12 " | 4 do. | 2 do. | 7 do. | 12·00 | W. P. Howland & Co. |
| Saw and Planing Machine. | 9 " | 1 upright saw. | All. | 166 ft. B.M. | 12·00 | do. |
| Do. " | 9 " | 1 do. and 2 circular. | All. | 125 do. | 7·00 | S. Scarlett. |
| Do. " | 9 " | 2 do. and 2 do. | All. | 125 do. | 11·00 | H. Dennis. |
| Do. " [Lathe. | 9 " | 2 do. and 2 do. | All. | 125 do. | 11·00 | E. Scarlett. |
| Woolen Factory & Turning | 12 " | | All. | | | J. Williams. |
| Grist Mill. | 12 " | 3 run of stones. | 1 run of stones. | 10 bushels ℔ run. | Not working | T. Somerville. |
| Saw " | 9 " | 1 upright & 1 circular | All. | 125 ft. B.M. | 11·6 | J. Dennis. |
| Grist " | 12 " | 3 run of stones. | 1 run of stones. | 10½ bushels ℔ run. | 12·00 | R. McDougall. |
| Saw " | 9 " | 1 upright & 1 circular | All. | 125 ft. B.M. | 10·00 | do. |
| Grist " | 12 " | 4 run of stones. | 1 run of stones. | 11½ bushels ℔ run. | 14·00 | C. & W. Wadsworth. |
| Saw " | 9 " | 1 upright & 1 circular | All. | 125 ft. B.M. | 11·00 | do. |
| Distillery. | 12 " | | All. | | | do. |
| Saw Mill. | 9 " | 1 upright & 1 circular | All. | 125 ft. B.M. | 10·00 | S. Dennis. [son. |
| Do. " | 9 " | 1 do. 1 do. | All. | 125 ft. | 6·00 | Christner or T. Mus- |
| Do. " | 9 " | 1 do. 1 do. | All. | 125 ft. | 8·00 | Grossen. |
| Grist " | 12 " | 2 run of stones. | 1 run of stones. | 8 bushels ℔ run. | 5·8 | H. J. Boulton. |
| Saw " | 6 " | 1 upright saw. | All. | 170 ft. B.M. | 5·8 | do. |
| Grist " | 12 " | 2 run of stones. | 1 run of stones. | 9½ bushels ℔ run. | 8·00 | Roundtree. |
| Saw " | 8 " | 1 upright saw. | All. | 125 ft. B.M. | 8·00 | do. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Saw | 8 " | 1 upright saw. | All. | 125 ft. B.M. | 8·00 | do. |

## BOSTON WATER WORKS.

*Statement shewing the number and kind of Water Tenants, with Amounts received from the same in the last Four Years.*

| 1853 | 1854 | 1855 | 1856 | | 1853 | 1854 | 1855 | 1856 |
|---|---|---|---|---|---|---|---|---|
| | | | | | $ | $ | $ | $ |
| 13,632 | 14,073 | 14,483 | 15,260 | Dwelling Houses | 119,891.18 | 124,977.06 | 157,318.88 | 169,129.69 |
| 2,845 | 3,031 | 3,263 | 3,515 | Stores, Shops, Offices, Cellars, &c. | 16,006.93 | 18,242.25 | 23,587.00 | 26,542.93 |
| 283 | 299 | 340 | 426 | Hotels, Restaurants, and Saloons | 6,459.57 | 10,302.09 | 10,895.63 | 11,065.53 |
| 480 | 518 | 551 | 648 | Stables | 6,515.38 | 6,869.14 | 7,578.75 | 8,297.10 |
| 8 | 7 | 7 | 8 | Railroads | 6,527.20 | 5,912.28 | 7,523.40 | 8,681.68 |
| 2 | 3 | 3 | 3 | Ferry Companies | 1,006.53 | 2,115.64 | 2,608.28 | 2,712.16 |
| 16 | 21 | 31 | 30 | Steamboats | 3,055.81 | 3,211,85 | 4,370.01 | 4,865.71 |
| 932 | 811 | 728 | 720 | Hose | 2,829·00 | 2,452,00 | 2,205.00 | 2,192.00 |
| 1 | 1 | 1 | 1 | Motive Power | 535.51 | 783.44 | 800.00 | 516.23 |
| 63 | 67 | 81 | 84 | Sug Ref. Distilleries, Breweries, & Bakeries | 6,635.93 | 7,303.49 | 11,237.20 | 10,202.25 |
| 3 | 4 | 4 | 4 | Gas Companies | 514.47 | 508.76 | 655.52 | 621.22 |
| | | | | Other Manufacturing Purposes | 16,247.23 | 18,738.22 | 18,272.51 | 22,857.68 |
| | | | | City Buildings and other City uses | ..... | 3,733.50 | 4,011.50 | 3,777.72 |
| | | | | Pub. Buildings, Charitable Institutions, &c. | 1,053.83 | 1,627.92 | 1,834.40 | 1,989.95 |
| | | | | Shipping Contract with Watermen | 3,900.06 | 4,647.08 | 4,223.78 | 4,387.30 |
| | | | | Street Waterers | 655.88 | 532.45 | 973.72 | 100.00 |
| | | | | Building Purposes | 609.93 | 917.40 | 735.05 | 1,085.05 |
| | | | | Other Purposes | 1,544.00 | 1,479.50 | 920.17 | 1,010.24 |
| | | | | | 193,988.44 | 214,354,07 | 259,750,80 | 280,034.44 |

# TABLE

*Shewing Statistics of the Metropolitan Water Companies of London, with the Amount expended under the Water Works Clauses Act of* 1847, *and the total Cost.*

| NAME OF COMPANY. | No. of Gallons pumped daily. | No. of Houses supplied. | Average No. of Galls. per House. | Origiual Cost. | Additions under Water Works Clauses Act. | Total Cost. |
|---|---|---|---|---|---|---|
| | | | | £ | £ | £ |
| Grand Junction ..... | 6,714,292 | 17,221 | 390 | 522,295 | 211,128 | 733,423 |
| Southwark and Vauxhall ..... | 10,331,122 | 41,529 | 249 | 435,247 | 214,010 | 649,257 |
| West Middlesex ..... | 6,895,368 | 25,732 | 268 | 648,560 | 157,400 | 805,960 |
| Lambeth ..... | 7,000,000 | 28,541 | 245 | 307,352 | 301,633 | 608,985 |
| Chelsea ..... | 6,914,300 | 25,030 | 276 | 455,712 | 472,324 | 928,036 |
| New River ..... | 25,000,000 | 95,083 | 263 | 1,421,717 | 566,084 | 1,987,801 |
| East London ..... | 16,000,000 | 70,000 | 229 | 745,781 | 250,000 | 995,781 |
| Kent ..... | 2,363,727 | 16,077 | 147 | 202,104 | 27,022 | 229,126 |
| Hampstead ..... ..... | 603,060 | 6,348 | 95 | 81,231 | 33,224 | 114,455 |
| Plumstead, Woolwich and Charlton ..... | 550,000 | 3,000 | 183 | ..... | ..... | 50,000 |
| | 82,371,569 | 328,561 | 250 | 4,819,999 | 2,232,825 | 7,102,824 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 82,371,569 | 328,561 | 250 | 4,819,999 | 2,232,825 | 7,102,824 |