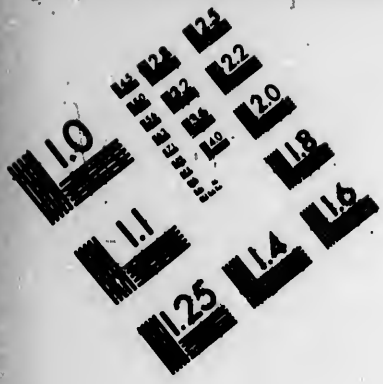

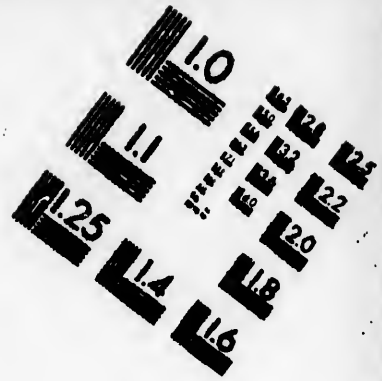

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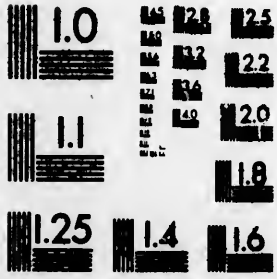

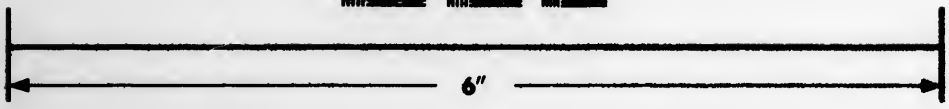

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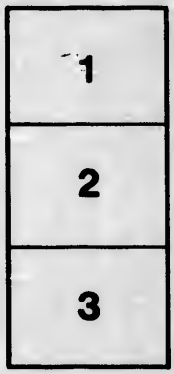

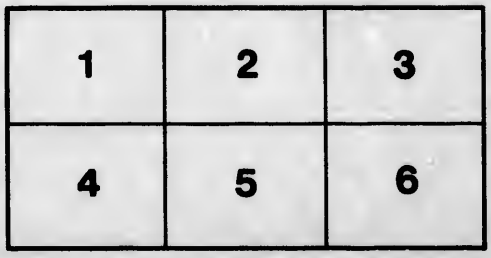

D 10

MAIN SEWAGE SYSTEM.

INTERCEPTING AND OUTFALL SEWERS.

1. REPORT TO COUNCIL, SEPTEMBER 1, 1886.
2. REPORT TO COMMITTEE ON WORKS, AUGUST 24TH, 1886, GIVING COSTS OF THE WORKS.
3. REPORT TO COMMITTEE ON WORKS, AUGUST 10TH, 1886, INTRODUCING REPORT OF HON. W. J. McALPINE.
4. REPORT OF MESSRS. McALPINE, TULLY, AND THE CITY ENGINEER.
5. CITY ENGINEER'S REPORT TO THE COMMITTEE ON WORKS, MARCH, 1886.

Presented to Council Sept. 2nd, 1886.

2668

CITY ENGINEER'S OFFICE,
Toronto, September 1st, 1886.

To His Worship the Mayor and the Council of the City of Toronto:

GENTLEMEN,—I see by to-day's papers that the matter of the Trunk Sewer has been referred back to the Committee on Works by the Executive Committee for further information. The Report made to the Committee on Works on the 24th August, 1886, was for the purpose of giving a general description of the work to be done and the cost thereof, in order to allow of a By-law being prepared and submitted to the ratepayers for their approval.

Messrs. McAlpine and Tully's Report, presented to Council on the 2nd of August, 1886, and which is included in the Minutes, gives full information as to the size and capacity and details of the several works to be done in the construction of the sewers.

I now beg to place before the Council this Report in pamphlet form, also my Report of March, 1886, which includes extracts from the Reports of preceding Engineers; and also the Report of Prof. Laud Carpenter and Prof McAdam, on the present state of the water of the Bay, and the necessity of providing other means of disposing of the City's sewage than those at present in use.

Mr. McAlpine, when calculating the size of the several sewers of this system, provided for the drainage of the sewers of the City with a population of 300,000 people, and ¼ inch of rain-fall in twenty-four hours. During very heavy storms he has provided for an overflow into the old sewer channels, so that there will be no possibility of damage to the works from flood water.

For the present, the proposed Front Street sewer will carry the ordinary sewage flow to the outlet The proposal is to construct this sewer at once, and follow with a second intercepting sewer on Gerrard Street, which will carry the sewage of the upper and northern portion of the City, relieving the Front Street sewer. The outlet sewer will be sufficiently large to carry the whole sewage of the City, with a population of 300,000. The expenditures on the sewers will extend over a number of years, probably ten years, before the whole scheme can be brought to completion. The construction of the Front Street sewer will relieve the harbor of the foulness now so much complained of by the citizens; and the sewage upon entering the lake at the outlet will be carried eastward, relieving the City completely from any further dangers from the effects of sewage.

The Reports now presented give all the information necessary to enable the members of the Council to arrive at a thorough understanding of the scheme.

The plan attached shews the course of the several sewers.

Respectfully submitted.

C. SPROATT.

(Approved) KIVAS TULLY.

CITY ENGINEER'S OFFICE,

Toronto, August 24th, 1886.

To the Chairman and Members Committee on Works:

GENTLEMEN,—I beg to report that all the necessary surveys have been made for the purpose of establishing a system of main intercepting sewers, and an outfall sewer for the removal of and the discharge of the City's sewage at some point where it will be carried eastward, and away from the City.

This system will consist of two main intercepting sewers from the western portion of the City eastward to the River Don. The first of these sewers will be constructed on Gerrard Street and on the line of Gerrard Street, extending westerly from Bellwoods Avenue to River Street.

The second intercepting sewer will connect with the Garrison Creek sewer, and from this connection will, from the flats of the Garrison Creek, cross the Doty property to Front Street, thence along Front Street to the River Don. These two sewers will be connected by a sewer laid along the flats of the Don River, southward from Gerrard Street to Front Street, and from this point the main outfall sewer will extend in a south-easterly direction, discharging the sewage at some distance from the shore into the waters of the Lake, 30 feet below the surface.

In addition to this, an intercepting sewer will be constructed along the Rosedale ravine, from Yonge Street, in a south-easterly direction, and will connect with the Gerrard Street sewer. This sewer will carry the drainage of the northern part of the City, generally known as North Toronto.

The estimated cost of the proposed main drainage of the City will be $1,395,784, approximately.

I have increased the cost as estimated by Mr. McAlpine and Mr. Tully and reported to Council by an amount of $280,684, the items being as follows:

For land damaged by the Gerrard Street sewer	$ 20,000 00
Extra work on Front Street sewer	50,000 00
Extension of outlet further eastward if found necessary	150,000 00
Additional for Engineer's expenses and contingencies	60,684 00
Total	$280,684 00

DETAILED STATEMENT.

Gerrard Street sewer	$ 62,845 00	
Repairs to roadway	11,000 00	
Connecting with sewers	49,000 00	
Land damages	20,000 00	
		$142,845 00
Front Street sewer	$147,007 00	
Repairs to roadway	15,000 00	
Sewer connections	27,600 00	
Chambers, gates, turnouts	34,000 00	
Ventilators	5,000 00	
		228,607 00

Connecting sewer	$ 37,559 00	
Repairs to roadway	7,111 00	
Ventilators	2,500 00	
		47,170 00
Outlet sewer, including iron piping		762,000 00
Rosedale Creek sewer		33,104 00
		$1,213,726 00
Add 15 per cent. for engineering and contingencies		182,058 00
Total		$1,395,784 00

I would recommend that the work be proceeded with, and that a By-law be prepared and introduced by the Chairman of the Committee on Works and submitted by the Council to the ratepayers in accordance with the conditions of the Act passed at the last session of the Ontario Legislature.

Respectfully submitted.

C. SPROATT,
City Engineer.

RECOMMENDATION OF THE COMMITTEE ON WORKS, AUGUST 24TH, 1886.

Your Committee would further recommend that in submitting the By-law to the people, that it be a part of the same that the debentures for the construction of the trunk sewer shall be issued year by year, in sufficient amounts only to provide for the work to be done in each year.

TORONTO, August 10th, 1886.

To the Chairman and Members Committee on Works:

GENTLEMEN,—I beg to lay before you the Report of the Hon. W. J. McAlpine, Civil Engineer, and Kivas Tully, Esq., C.E., who was associated with him, on the main drainage of the City. The Report embraces, as you are aware, two intercepting sewers, one located on the line of Gerrard Street, and the other along Front Street, from the Garrison Creek sewer to the Don River. Either of these main sewers can be built separately. The Report shews the necessity of commencing and completing this work at as early a date as possible, and I would ask the Committee to provide funds for the construction of the Front Street intercepting sewer. The amount required will be $300,000. A question may be raised as to the position of the outlet into the lake; but this is a matter that can be determined during the construction of this portion of the work, as it will not in any way interfere with the final disposal of the sewage.

Respectfully submitted.

C. SPROATT,
City Engineer.

REPORT

OF THE

Hon. W. J. McAlpine, Civil Engineer,

KIVAS TULLY, Esq., Civil Engineer,

WITH WHOM WAS ASSOCIATED THE CITY ENGINEER,

ON A SYSTEM OF

Intercepting and Outfall Sewers,

and the final disposal of the Sewage of the City of Toronto.

Presented to the Mayor and City Council, at its Meeting held August 2nd, '86.

To His Worship W. H. Howland, Mayor, and the City Council of Toronto :

GENTLEMEN,

In obedience to your resolution of April 12th, 1886, in the following words :

"Your Committee begs to report that it has had under consideration the importance of proceeding as rapidly as possible with the preliminary arrangements for carrying out the projected trunk sewer system of the City ; and whereas the question of a proper system of drainage is of vital importance in the interest of the health of the citizens of Toronto, your Committee recommends the Council to engage the services of Messrs. Kivas Tully, of Toronto, and Hon. Wm. J. McAlpine, of New York, Civil Engineers, to be associated with Mr. C. Sproatt, City Engineer, for the purpose of making a Report as to the best system of drainage and means of disposing of the sewage of the City, and also the best means of dealing with the marsh and Ashbridge's Bay, accompanying the same with the necessary plans and an estimate of the cost, &c., and that the sum of $5,000 be placed to the credit of your Committee on Works for the said purpose."

We beg leave to respectfully report as follows :

The City of Toronto is built upon a sloping plain, rising from the shore of the Bay at an average rate, one in seventy-five, to a crest about 10,000 feet from the Bay, from which the ground falls steeply to the Rosedale creek, a branch of the River Don.

This plain also slopes eastward from Spadina Avenue towards the Don, at an average rate of about one in three hundred, and westward to the Garrison Creek.

The topography of the City is well adapted to the application of a complete system of drainage at a comparatively small expense. The slopes from the crest towards the Lake are sufficient to give the necessary drainage with sewers of moderate size, while those from Spadina Avenue eastward are in the direction in which the intercepting sewers must be laid towards the only places where they can be properly discharged.

The contamination of the water of the harbor and of the atmosphere of the adjacent districts of the City therefrom, and the serious effects upon the health of the people being acknowledged by all, renders it unnecessary that we should discuss that branch of the subject further than to specify the plans which are necessary to remedy the evils.

These plans are apparent, viz. : To intercept the sewage which now flows directly into the harbor and convey it to the deep water of the Lake, where it will be disseminated without injury to the comfort and health of the community.

The water supply of the City is obtained from the Lake, opposite the western end of the harbor, and the discharge of the sewage must be sufficiently

remote therefrom to protect the former from any possible contamination from the latter.

The places which have heretofore been considered as proper for the discharge of the intercepted sewage have been as follows: First, into "Ashbridge's Bay"; second, into the Lake, just east of the eastern cut or entrance to the harbor; third, across the middle of "Ashbridge's Bay" and into the Lake; and fourth, into the Lake, opposite Victoria Park.

The River Don, which now enters the harbor at its eastern end, drains a considerable area of the lower part of the City, and in its present condition seriously contaminates that portion of the harbor.

One of the subjects we have been called upon to examine is that of straightening this river, closing its present entrance and opening a new one in a direct line to the Lake across the marsh at the head of Ashbridge's Bay, and bringing into use for manufacturing and commercial purposes the low marsh land at the head of this Bay by means of a series of canals and the filling of the adjacent lots to the proper level above the Lake.

[NOTE.—This river is a legal navigable channel as far north as Winchester Street, and if closed as proposed will entitle the owners of abutting property to a new navigable outlet to the Lake.]

It is understood that the municipal government propose to dredge and side pile a new channel for the Don across the marsh, and extend protecting piers into the Lake, and close up the present channel into the harbor.

It will be subsequently stated that we recommend the carrying out of these projects, and therefore it would not be proper to discharge the sewage of the City into this Bay.

The closing of the present outlet of the Don and the opening of a new channel to the Lake will afford facilities for the construction of the sewer to convey the combined sewage of the City to the deep water of the Lake.

We shall subsequently discuss the effect of the discharge of the sewage at this place and also opposite Victoria Park upon the great body of the Lake water.

For the purpose of intercepting the sewage from the lowest portions of the City, and because of the low level of the surface of the street, we have arranged for an intercepting sewer on Front Street, upon the lowest rate of descent that the case admits (viz., 1 in 2,000), and for the purpose of economizing the whole cost of the intercepting drainage we have arranged for another sewer on Gerrard Street and its extension westward, because this street and line permits the use of a much steeper rate of descent (viz., 1 in 241), so that the different parts of the Gerrard Street sewer will be much smaller and the whole drainage less expensive than if all of the sewage, &c., was conveyed in one sewer on Front Street.

We have arranged to commence these intercepting sewers in the valley of Garrison Creek, but of a capacity at that place equal to that which will

ultimately be required when the City limits extend westward to Grenadier's Pond and is occupied with an assumed population, and the intercepting sewer is extended to the western limits above stated.

It is true that this extension of drainage will include the district of Parkdale, which is now an independent municipality; but whether Parkdale is or is not annexed to Toronto, it is almost as important that its sewage shall be intercepted from entering the Bay as that of the district of the City immediately east thereof.

We have also considered and approved of the plan of the City Engineer for an intercepting sewer down Rosedale creek and the Don to Gerrard Street. This sewer, however, is not designed to carry the storm water of that district, which it is proposed to allow to flow down the creek as it now does.

Annexed hereto is a list of the main sewers which now discharge into the harbor, including the Garrison Creek sewer, which discharges just west of it, giving their form, dimensions and slopes.

We have arranged the dimensions of the intercepting sewers so as to convey all of the sewage and a certain portion of the storm water from the area of the City when enlarged and when its population shall have been doubled, and with the conduits running only three-fourths full.

The amount of storm water to be carried off by the sewers will always be substantially the same, but the amount of sewage will be increased with the increase of population.

In the annexed tables it will be seen that the former is about twice that of the latter, and therefore the sewers as herein arranged will actually be of sufficient capacity when the present population shall have been quadrupled.

The average amount of sewage per head of population is equal to ten cubic feet in twenty-four hours, and the maximum at any time during the day is assumed at the rate of fifteen cubic feet per day.

The present population of the City is about 130,000, which we have estimated may be doubled in twenty years. We have sub-divided the City into districts, and have distributed this estimated future population to the several sub-districts, and have arranged the size and slope of the different sections of the sewers in accordance therewith.

We have arranged for the discharge of storm water equal to a rate of one-fourth of an inch of rain in twenty-four hours, and if the storm is of less than six hours duration the water from a storm of one inch will not reach the intercepting sewers at a rate exceeding that provided for.

In the City Engineer's Report of March, 1886, is quoted from the reports of the Toronto Observatory as follows: The greatest depth of rain which fell on a single day from 1840 to 1874, and a statement of the heavy rainfalls in the years 1876 to 1884, giving the depth of each in inches and the duration of the rain in hours:

"The greatest fall stated is that of September 1st, 1878, viz., of 1·42 inches in one hour; another on August 6th, 1878, of 1·26 inches in one hour; another on August 4th, 1878, of 3·45 inches in four hours; another on August 2nd, 1879, of 0·85 inches in one hour; another on 24th June, 1884, of 0·86 inches one hour; another on 4th July, 1878, of 1·98 inches in four hours; another on July 27th, 1877, of 0·90 inches in two hours, and another on September 13th, 1880, of 3·09 inches in twelve hours."

The rate at which the water from the heavy rainfalls will reach the main sewers depends upon the condition of the earth from previous rains, or from being frozen, paved or covered in part by buildings on the slopes of the ground, and the amount and duration of the storm.

These conditions are so variable that no general estimate of the rate of flow off can be definitely determined from any given area or rainfall; we are therefore compelled to assume the most unfavorable conditions.

From the preceding statement of the heavy rains which have occurred, it is evident that it would be inexpedient to provide capacity for the conveyance of the whole of the occasional heavy rainfalls through the intercepting sewers.

It is, however, sufficient for the present discussion to state that the existing outlet sewers have been found capable of carrying off all of the storm waters, and that an arrangement has been devised by means of which the sewage and water from ordinary rains will be turned into the intercepting sewers, and when the storm water exceeds the amount above specified the surplus will be automatically turned into the present main cross sewers and be discharged into the harbor as they now are, but with nearly all the sewage matter abstracted therefrom.

The storm water which will thus be discharged into the harbor will have been deprived of all of the heavier and most objectionable parts of the sewage, and will have been greatly diluted in the sewers and again by the harbor water, so that it will be almost innocuous and be entirely so before any of it could under any circumstances reach the inlet pipe of the water supply.

There can therefore be no reasonable objection made to the discharge of the excess of the heavy storm water into the harbor in the manner proposed.

We have provided that the intercepting sewers shall be large enough, when running three-fourths full, to carry off the sewage and the part of the storm water above stated. This will leave a space above the fluid for the collection and passage of the mephitic gases to the ventilators.

In extraordinary rain storms this space can be temporarily utilized by turning much more of the storm water into the sewers for a few hours.

The present surface grade of Front Street, east of Simcoe Street, is so low that when the top of the sewer is placed at its proper depth below the street the surface of the fluid in the intercepting sewer will sometimes fill

up the space to the crown of the arch, or even produce a slight hydraulic pressure upon it. The extent of this pressure will, however, never endanger the stability of the arch.

To two particular plans we have given our special attention, viz.: The one which contemplates the collection of all the drainage of the City in Front Street near the Don, and its conveyance across the marsh at the head of Ashbridge's Bay to the Lake, and into the latter where the water is thirty feet deep.

The other plan provides that the drainage collected by the Gerrard Street sewer shall be carried across the Don on a bridge forty feet above the Lake level, and that the remainder of the drainage of the City shall be collected in a low level tank at Gerrard Street near the Don and pumped up by steam power into an upper tank from which it will flow into the Gerrard Street sewer across the Don, and from thence the combined drainage will be carried to Victoria Park and into the Lake where the water is thirty feet deep.

On the first of these plans the masonry conduits will discharge into a chamber near Front Street and the Don, and from thence the sewage will be conveyed in iron or steel pipes. For the first 4,250 feet the pipes will be supported by piles and cross timbers, for the next 2,500 feet on the crib protections to the new entrance channel of the Don, and then for 4,100 feet the iron pipes will be laid upon the bed of the Lake and protected from the dragging anchors of vessels with a timber frame and a mound of large stone.

At the outer end of these pipes a low crib will be sunk, so as to place the outlet of the pipes six feet above the bed of the Lake.

On the other plan the combined drainage will be conveyed in a sewer of masonry from the east side of the Don to Victoria Park, a distance of 26,400 feet, and thence for 3,500 feet by iron pipes on the bed of the Lake, protected from anchors, and with a low crib at the end, as has been described above.

Annexed hereto is a table showing the drainage areas of the sub-divisions, the quantities of sewage and storm water required to be conveyed in the several parts of the proposed intercepting sewers, and also the length, slope and size of each.

The estimated cost in detail of each of the plans is given in the annexed statement.

The aggregate cost of the first plan will be $1,115,100, and of the second plan $1,642,665. Difference in favor of the first plan $527,565.

[Note.—Since the Report was submitted we have found that a steel pipe of seven feet diameter, $\frac{5}{8}$ inch metal, reinforced, can be substituted for the two cast iron pipes of five feet diameter, and save $117,000, which will reduce the cost of the first plan to a little less than one million of dollars. We are of opinion that the steel plate pipe is preferable to those of cast iron.]

If the sewage can be discharged into the Lake at the mouth of the Don without endangering the contamination of the water which is supplied to the City, the first plan will no doubt be adopted.

The general movement of the waters of Lake Ontario is eastward, with an average flow of about forty feet per hour.

To determine whether there are any eddies or currents moving in the opposite direction or from either entrance of the harbor toward the intake pipes of the Water Works, a series of floats have been put in the harbor and in the Lake from the mouth of the Humber to opposite Victoria Park.

These floats were of 6 to 40 feet depths, and were put overboard from day to day in May and June last, during which the winds were from every direction.

The course and distance moved by each of the floats and the direction and strength of the wind are given in the accompanying chart.

The analysis of their movements is as follows. (See Appendix.)

On the first plan, with the discharge 4,100 feet south of the proposed new mouth of the Don, the contents of the sewer would enter the great body of the Lake waters with a velocity of three miles an hour and spread in every direction until its motion was lost. During this time all of the contained matter, which is heavier than water, would be precipitated to the bottom of the Lake and remain there, because there is not sufficient motion in the Lake water to maintain it in suspension.

The eddies and counter currents which the protective piers of the Don channel will make in the lake water will further diffuse and separate the lighter portions of the sewage fluids.

There is an almost constant current in the entrance between the lake and the harbor, caused by the winds. Those from the east southerly drive the water into the harbor at its east entrance and out at the west inlet, and with the winds from the contrary direction the currents are reversed.

These currents will again disperse and deflect the already greatly diluted sewage fluid, and even with a north-easterly wind blowing directly towards the City water intake, the continued dilution and diffusion of the sewage liquid will prevent the carriage of any portion of the objectionable matter to the intake. The course from the proposed sewer outlet to the Water Works is S 39° west

The difference between the temperature of the liquid sewage and the lake water into which it is injected will greatly aid the diffusion of the former. In the summer and autumn the difference in temperature will generally be at least eight or ten degrees (Faht). The infused warmer liquid will continue to rise until it has lost its excess of temperature, and will then be still more diluted.

Those portions of the sewage fluid which are lighter or warmer than the lake water will rise to the surface, where the air will oxygenate its impurities or drive off the impurities in aerated form.

On the 31st of May last the temperature of the water in the lake at the water works intake at 18 feet below the surface was 46 degrees; at 30 feet below, 44 degrees; at 42 feet depth, 42 degrees, while at the surface it was about 46 degrees.

On the same day opposite the proposed new outlet of the Don the temperature of the water at 50 feet depth was 42 degrees, and at the surface 46.

In the late summer the deep water temperature of the lake will generally be a few degrees warmer.

The temperature of the sewage fluid in the City sewers on July 31st, 1886, was 52 to 54 degrees, which is about 8 or 10 degrees warmer than the deep lake water.

The specific gravity of the two is as 1 to 1.0003.

[NOTE.—After the Report was submitted, viz., on the 3rd of August, Messrs. McAlpine and Tully made an examination of the temperature of the Lake water directly off from the proposed new outlet channel of the Don, in water 30 feet deep, and found it to be 46 degrees at the bottom and 48 degrees at the surface, the temperature of air being 59 degrees. At the same time they also ascertained that the temperature of the water at the bell buoy of the Water Works inlet was 43 degrees at 30 feet depth and 44 degrees at the surface. The water of the harbor at York Street wharf was 58 degrees and of the air 60. This note has been added because of a Report which was submitted to the commission stating that the temperature of the Lake water at 30 feet depth, opposite the proposed new outlet of the Don, was 56 degrees, which Report we found to be erroneous.]

The flow of the sewage in the Gerrard Street intercepting sewer will be at the rate of five miles an hour, and in the Front Street sewer over two miles an hour. If the decomposible portion of the sewage from the houses to and through the existing sewers has the same velocity as it will have in the intercepting sewers, that which enters the latter from the most remote districts of the City will be discharged into the lake before much decomposition can take place, and the most of it before it commences; so that with proper care there will be but very little gas discharged at the ventilators, and that little will be diffused and oxygenated by the winds before it can become injurious or offensive to the people along the route of the sewer.

Let us consider the effect of the most unfavorable circumstances, viz., that of a strong protracted gale blowing in a direct line from the sewer discharge to the intake pipe, viz., S. 39° W. Those portions of the sewage which are heavier and those which are lighter than the lake water would be disposed of as before described. Those of the same specific gravity, but of higher temperature, would be mixed up and diluted as before stated by the gale and its waves to such an extent that only in infinitessimal and exceedingly diluted portions could reach the intake nearly three miles distant and twenty feet below the surface.

The most delicate chemical tests would fail to detect the presence of any objectionable matter therefrom in the large volume of the water pumped into the City.

Even under such extremely unfavorable circumstances, and merely as a concession to public opinion, it would perhaps be advisable to refrain from pumping during these very rare occurrences.

If further observations in regard to the under currents of the lake in about thirty feet of water shall show that there will be danger of any of the discharged sewage reaching the intake of the Water Works, the proposed new outlet of the Don can be carried a mile or more to the eastward, and the outlet of the intercepting sewer also carried the same distance to the eastward.

This would increase the length of the intercepting sewer and also its size or slope, and its cost by probably $100,000.

On the second plan the discharge of the sewage into the Lake opposite Victoria Park would be attended with the same conditions as above described; but the distance from the discharge to the intake of the water supply is more than twice as great, viz., six and three-tenths miles.

This increased distance would tend to dilute and diffuse the sewage fluid more than on the first plan; but, on the other hand, there would not be the effects of the immediate eddies and cross currents caused by the piers at the Don. We do not believe that the sewage discharge into the Lake at either of these places could under any circumstances reach the water which is now pumped into the City.

Having in view all of the circumstances of the case, and considering that the extension of the place for the discharge into the Lake at Victoria Park is of doubtful benefit, while its cost and the annual cost of the pumping is so much greater, we are of the opinion that the first plan, viz., that of discharging the collected sewage of the City opposite the new mouth of the Don, located as we have indicated, should be adopted.

The cost of the works herein proposed may be extended over several years.

The closing of the old and the opening of the new channel of the Don and the building of the Front Street sewer, as above stated, would be of immediate and great advantage to the health and comfort of the citizens.

The subsequent construction of the Gerrard Street intercepting sewer and the other works herein recommended would entirely relieve the City from the existing evils growing out of the use of the harbor as a cesspool for the sewage of the City.

EXTENSION OF INTERCEPTING SEWERS.

In the construction of the extension of the intercepting sewer, from the junction of the Gerrard Street and Rosedale sewers with the Front Street sewer at its eastern termination, it is necessary to cross the existing outlet

of the Don. An embankment will have to be constructed across the River Don in order to maintain the hydraulic slope of the extension for the intercepting sewers from Gerrard and Front Streets.

The embankment will have to be continued across the marsh to the Lake shore in order to protect the sewer or iron pipe from the effects of the frost. At the entrance of the channel a cribwork 40 feet in width, loaded with stone, and of a sufficient height to form a substantial pier on an average 20 feet in height, forming the western side of the new entrance to the Don, will also form a protection for the sewer in its passage to the Lake. Cribwork of similar construction will be required on the eastern side of the entrance, leaving a channel 200 feet in width between the piers. This channel to be dredged out to afford a depth of 14 feet of water. The channel should of course be extended to the River Don to form a new entrance to the Lake in place of the present outlet, which will be closed. The channel across the marsh should also be dredged to afford 14 feet of water, and the sides would have to be protected by sheet piling, 3 feet above high water, formed of two rows of cedar piles 10 feet apart, the piles 10 inches in diameter and 16 feet lengths, to be driven close, with stringers on the outside stayed with 1 inch iron bolts and nuts 5 feet apart, to prevent the soft clay of the marsh from filling up the channel when dredged. The material dredged to be placed behind the sheet piling, forming a protection to the sewer extension on the western side, completing the new outlet to the Don on the eastern side. The cost of this latter work, which would be an extension of the proposed Don improvement, would not be properly chargeable to the extension of the intercepting sewer. The sheet piling and cribwork on the western side forming, as it would, a protection for the sewer extension, has been estimated as part of the cost of the intercepting sewer.

The diversion of the River Don from the harbor into the Lake, with a new entrance as above described, is as necessary to the purification of the water in the harbor as the interception of the sewage by the construction of the sewer along Front Street; and when the new entrance has been constructed as part of the projected improvement for the straightening of the River Don all objections with respect to riparian rights would appear to have been met in a liberal and considerate manner.

IMPROVEMENT OF THE MARSH.

According to recent surveys, the quantity of land and marsh in what is termed as Ashbridge's Bay is about 1,385 acres. The northern boundary extends from east to west along the shore line of the Bay; the boundary has been defined by a line drawn over 500 feet south of the tongue of land extending from Scarborough Heights to the eastern cut into the harbor, the western boundary being the eastern shore of Toronto Bay. In order not to interfere with the riparian rights of owners along the northern boundary, it is proposed to leave a channel 200 feet in width, with 12 feet of water extending from the new Don channel to the eastern end of Ashbridge's Bay

so that each of the land owners along this boundary will have a water frontage equal to the width of their respective lots.

It is further proposed to leave another channel 200 feet in width south of and parallel to this, with three cross channels running north and south 200 feet in width connected with the eastern and western channels, and with two large basins, one on the eastern end at the proposed additional entrance and the other at the western end connected with the new channel at the River Don. By this arrangement the greater portion of the Bay will be divided into 52 water lots of over 5 acres each having frontages on the above mentioned channels, and to be connected with each other and the shore on the north by means of swing bridges at the principal streets. The above arrangement is indicated on a plan which accompanies this Report, and which will also explain the extension of the intercepting sewer.

The space between the eastern shore of the Toronto Bay and the new channel to the River Don to be divided into 20 lots of about 8 acres each having frontages on the Toronto Bay and Don channel. The beach forming the southern boundary of Ashbridge's Bay has been divided into 27 lots of about 10 acres each having a double frontage on Ashbridge's Bay and the southern boundary in the lake. The total quantity thus laid out into lots being 690 acres, about one-half of the total quantity as surveyed, 1,385 acres.

The material to be dredged from the channels to be deposited inside the sheet piling, which is arranged to enclose seven blocks forming the 52 water lots.

Excavations from City building lots, refuse and other superfluous materials can be deposited in these enclosures, which when filled up will no doubt in a few years be required for manufacturing and other purposes.

By this arrangement the drainage of the low lying portions of the City east of the River Don will be provided for in as ample a manner as can be accomplished without the use of a pumping apparatus, as the two entrances to Ashbridge's Bay will induce a current from the lake by the annual rise and fall of the water and constant fluctuations caused by the winds on the surface of this water, which will keep the water comparatively pure and improve the sanitary condition of this portion of the City, an improvement much required.

If these improvements are carried out, which, as a matter of course, will be extended over several years, the marsh, which is now a detriment to the progress of the eastern portion of the City, may be made beneficial eventually and profitably for the capital invested.

WM. J. McALPINE.
KIVAS TULLY.
C. SPROATT,

Toronto, August 2nd, 1886.

The undersigned entirely agrees with the above Report and its conclusions, except that he is of the opinion that at certain times there is a westward movement of the water in the Lake along the southern shore of the Island, which he fears may convey some portion of the objectionable matter discharged by the sewer if its outlet is located too near the intake of the Water Works, and therefore he is of the opinion that the outlet of the sewer should be kept as far as possible to the east of the Water Works intake.

C. SPROATT.

APPENDIX NO. 1.

Estimates of the Cost of the Proposed Intercepting Sewers.

FIRST PLAN.

Discharging into the Lake opposite the proposed new channel of the Don.

The Gerrard Street sewer, 14,000 feet long, egg-shaped areas, equal to from 3 to 3¾ feet diameters.

51,220 cubic yards of excavation and refilling, 60c....		$30,732 00
4,000 feet brick sewer, equal to 3 feet circular diameter, $6.25 per cubic yard.....	$8,333 00	
2,000 feet brick sewer, equal to 3¼ feet circular diameter, $6.70 per cubic yard.....	4,467 00	
6,500 feet brick sewer, equal to 3½ feet circular diameter, $7.16 per cubic yard.....	15,513 00	
1,500 feet of brick sewer, equal to 3¾ feet circular diameter, $7.60 per cubic yard.....	3,800 00	
		32,113 00
Replacing roadway, 11,000 square yards, $1.....		11,000 00
Connections with cross sewers, ventilators, &c.....		49,000 00
		$122,845 00

Connecting sewers from Gerrard to Front Street, 4,000 feet in length.		
30,822 cubic yards of excavation and refilling, 60c....	$18,493 00	
4,000 ft. of brick sewer, equal to 3¼ ft. diameter, $6.70.	8,933 00	
4,000 ft. brick sewer, equal to 3¾ ft. diameter. $7.60..	10,133 00	
Replacing roadway, 7,111 square yards.....	7,111 00	
Ventilators, &c.....	2,500 00	
	$47,171 00	
Front Street sewer, Garrison Creek to the Don, 15,700 feet.		
57,629 cubic yards excavation and refilling, 60c.....	34,575 00	
1,700 feet of brick sewer equal to 4 feet diameter, $8.16.....	$ 4,624 00	
200 feet of brick sewer equal to 4½ feet diameter, $14.70.....	9,800 00	

2,500 feet of brick sewer equal to 5 feet diameter, $16.15	13,458 00		
5,000 feet of brick sewer equal to 5¼ feet diameter, $16.80	28,000 00		
4,500 feet of brick sewer equal to 5½ feet diameter, $17.70	26,550 00		
		82,432 00	
Replacing roadway, 15,000 square yards		15,000 00	
Connections with cross sewers:			
10,000 cubic yards excavation, etc, 60c	$ 6,000 00		
1,800 cubic yards brick masonry, $12	21,600 00		
Turnout sewers, chambers, gates, etc., 3,400 feet	34,000 00		
10 ventilators, etc	5,000 00		
		66,600 00	
			198,607 00
Cast iron pipes, Front Street to the Lake, 4,250 feet, $50		$212,500 00	
2,450 feet in crib work, $60		147,000 00	
4,100 feet into the Lake, $50		205,000 00	
Crib and chamber		5,000 00	
4,250 feet sheet piling, $10		42,500 00	
			612,000 00
The City Engineer's estimate of the Rosedale Creek sewer is			33,104 00
Add ten per cent. for contingencies and superintendence, making the total cost of the first plan			$1,115,100 00

SECOND PLAN.

Discharging into the Lake opposite Victoria Park:			
The Gerrard Street sewer, as on the first plan			$122,845 00
The Front Street sewer, as on the first plan			198,607 00
Connecting sewer, 14,000 cubic yards excavation and refilling, 60c	$ 8,400 00		
4,000 cubic yards brick sewer, $12	48,000 00		
Ventilators, etc	5,000 00		
			61,400 00
Sewer, Gerrard Street to Victoria Park, 140,000 cubic yards excavation, etc, 60c	$ 84,000 00		
20,600 feet of brick sewer, $25	515,000 00		
Culverts, etc., per Mr. Sproatt's estimate	4,880 00		
			603,880 00
Engines, houses, bridge over Don, and land			326,600 00
Pipes into the Lake 3,500 feet, at $50	$175,000 00		
Crib and chamber	5,000 00		
			180,000 00
			$1,493,332 00
Add ten per cent. for contingencies and superintendence			149,333 00
The annual cost of pumping, per Mr. Sproatt's estimate, is			43,445 00
The capital, the interest of which at 5 per cent. on the same, is equal to			$868,900 00

APPENDIX No. 2.

Table of the Sub-Divisions of the Drainage Areas.

The Upper Sewer in Gerrard Street, &c.	Area of Acres.	Estimated Population.	Cubic Feet per Second.				Sewers Proposed.		
			Sewage.	Storm Water.	Of both.	Total.	Length.	Slope.	Diameter.
							feet.		ft.
From west of Bellwood..	1,840	27,600	4·78	19·32	24·10	24·10	.....	1 in 2700	3
Bellwood to Bathurst	240	6,000	1·04	2·52	3·56	27·66	2,000		3
to Spadina.....	370	11,100	1·93	3·89	5·82	33·48	2,000		3
to Simcoe.....	300	9,000	1·57	3·15	4·72	38·20	2,000		3½
to Yonge.....	280	14,000	2·44	2·94	5·38	43·56	2,500		3½
to Sherbourne.	260	13,000	2·26	2·73	4·99	48·57	2,500		3½
to Parliament .	80	4,000	0·70	0·84	1·54	50·11	1,500		3½
to the Don.....	80	4,000	0·70	0·84	1·54	51·65	1,500		3½
Totals.....	3,450	88,700	15·42	36·23	51·65		14,000		
The Lower Sewer in Front Street.									
From west of Bathurst...	1,570	31,400	5·46	16·49	21·95	21·95	1,700	1 in 2,000.	4
to Simcoe.....	552	33,120	5·77	5·80	11·57	33·52	4,500		4½ 4½ 5
to Sherbourne	410	24,600	4·28	4·31	8·59	42·11	5,000		5½
to the Don....	318	15,900	2·77	3·34	6·11	48·22	4,500		5½
Totals.....	2,850	105,020	18·28	29·94	48·22		15,200		
Connecting Sewers.									
Down Rosedale Creek to Gerrard.....	1,100	22,000	3·83	11·55	15·38	.....	.....		
East of the Don.....	600	15,000	2·61	6·30	8·91	.....	.....		
Gerrard to Front.....	100	5,000	0·87	1·05	1·92	.....	4,000		
Totals.....	1,800	42,000	.....	.....	.....		4,000		
Gerrard Street to Victoria Park.....	.....	.....	.....	.....	.....	126·08	20,600	1 in 2,000. 1 in 687.	6½
Front Street to the Lake (two iron pipes of 5 feet diameter).....	.....	.....	.....	.....	.....	126·08	10,800		8

Population of districts not embraced in the above 24,280 makes the total estimated population 260,000.

NOTE.—The fourth column is obtained by allowing 15 cubic feet per day for each head of population. The fifth column by allowing one-fourth of an inch per day per acre.

APPENDIX NO. 3.

Main Sewers entering the Bay, with their Size and Inclination.

STREET.	SIZE.	GRADE.
	′ ″ ′ ″	′ ′
Cherry Street	2 8 x 4 0	1 300
Parliament Street	3 6 x 5 0	1 130
Sherbourne Street	2 8 x 5 0	1 120
Jarvis Street	3 6 x 5 0	1 100
Church Street	2 8 x 4 0	1 100
Yonge Street	3 6 x 5 0	1 90
Simcoe Street	4 0 Circular.	1 85
Brock Street	4 0 x 5 6	1 100
Bathurst Street	2 6 x 3 9	1 82

CITY ENGINEER'S OFFICE,

TORONTO, MARCH, 1856.

To the Chairman and Members of the Committee on Works:

GENTLEMEN,—As instructed by your Committee, I have the honor to lay before you such information as I have gathered during the last two years in reference to the sewerage of the City, the system in use, the manner of its disposal, with the area drained, the length of the sewers at present laid down, and the amount spent on drainage works to date, estimating the value of the earlier works by the cost of similar works at the present time. I also lay before you proposals, and the estimated cost of intercepting and outfall sewers. The first brick sewers were constructed in the year 1843, John G. Howard, Esq., being at that time City Engineer. Whether any system was adopted in laying down these sewers or not I cannot say; but it is very probable, as these sewers were laid over a small area of the City, that there was none. However that may be, they had one thing in common with the present system, that is, they discharged into the waters of the Bay.

Mr. Thomas H. Harrison was appointed City Engineer in the year 1856, and in the following year he reported on a system of drainage for the City and its liberties. In this Report he recommended that the City be divided into a number of drainage areas. He states:

"The City embraces the various streets now laid out or proposed to be opened between the 2nd concession line on the north (Bloor Street) and the Bay on the south, the Don River on the east and the Garrison Creek on the west."

In this Report he mentions two creeks, one entering the Bay at Simcoe Street, the other at Parliament Street, which he states have been sources of great annoyance by their overflowing in the spring and fall, causing considerable damage to the property, and which he proposes to tap by various main sewers. He mentions the creek through the College grounds, now known as the University Creek, as having already been tapped by Simcoe Street and William Street main sewers.

The area then embraced by the City he divided into eight drainage districts, each area having a main sewer running north and south. No. 1 draining into the River Don, No. 8 into the Garrison Creek, the intermediate areas draining into the Bay at the Esplanade front. The mains were recommended to be constructed on Parliament Street, Jarvis Street, Yonge Street, Simcoe Street (already constructed, 1854), Brock Street, Spadina Avenue, and Bathurst Street. Mr. Harrison in his report gives the cost of several which he recommends to be constructed.

Mr. Tully, reporting to the Chairman of the Board of Works (Mr. John Worthington, on this report, says that he approves of the system laid down by Mr. Harrison, and in conclusion says, "that by this plan and report the

whole sewage of the City may, at any subsequent period, be carried easterly across the River Don should it be desirable to do so.

"The principal objections to the system of drainage as proposed in the Report of the City Engineer, lie in the apparent necessity of using the bay as a receptacle for the refuse of the City year by year. As the population increases, the inconvenience and unhealthiness of adopting this course will be evident, and sooner or later a different arrangement will be adopted. The public mind is not yet prepared to carry out the suggestions which have been propounded in Europe, of rendering the refuse of large cities useful and profitable as a liquid manure."

The recommendations made by Mr. Harrison were adopted by Council and the work carried out, and, with the exception of the Yonge Street sewer, these sewers are at present in a good state of repair, and carrying the sewage of their respective drainage areas. No action having been taken by the Board of Works or Council to carry out the suggestions made by Mr. Tully for an outfall sewer until the appointment of Mr. Frank Shanly as City Engineer in 1875, one of his first works on taking office was to carry out a complete survey of the City, and establish bench marks throughout its limits. Surveys were made, and plans prepared for a main offtake sewer. Mr. Shanly reports as follows: "Commencing at the intersection of King Street and the Garrison Creek, it (the offtake sewer) passes from thence to Front Street at Bathurst Street, thence along Front Street to the River Don, a distance of 5,500 lineal yards, divided into three sections respectively, 6 feet, 7 feet, and 8 feet inside diameter brick sewer; estimated cost $160,000, including culverts, ventilating shafts, connections, etc., etc., but not including the diversion of the river Don from below the railway bridge into Ashbridge's Bay, which is essential to the success of the scheme, and which I have estimated to cost $30,000, adding for contingencies $10,000, will bring the total cost of sewer to $200,000. The total available fall will be 15 feet, or about 5 feet in a mile, sufficient for all practical purposes, when it is taken into consideration also that it will be constantly flushed by the waters of the Garrison, College, and other creeks entering it from the north at several points."

Provision is made for the storm water to overflow into the old channel of the creek to be carried into the lake. This report states further "there may be some practical difficulties in the way of this scheme, not the least is the diversion of the Don, in the view of it being navigable waters and the cutting off its communication from Toronto Bay, might be considered as an interference with vested rights; but as regards the physical question of the diversion, there is no obstacle in the way, it being a mere question of dredging; neither have I any doubt that the flow of water from the source above named will afford an under current ample to keep the sewer flushed where it is subject to back water, and to carry the whole deposit into Ashbridge's Bay, from whence it will be dispersed into the open lake.

"After a careful consideration of the whole question for the last two years, I feel convinced that there is no other feasible scheme for freeing Toronto

Harbor from the sewage of the City, and that measures should be taken without delay for carrying it out."

Mr. Shanly's successor, the late Mr. Brough, in his annual Report for the year 1882, made the following report on the main sewers required for carrying the sewage of the City into the Lake.

GARRISON CREEK SEWER.

During the summer approximate estimates were submitted for a main trunk sewer on the line of the Garrison Creek, and for an intercepting sewer along the front of the City.

The sewer on the line of the Garrison Creek is required as an outlet for several districts already sewered and discharging into the stream, as well as for other districts awaiting sewerage, and having only this outlet to depend upon.

The sewer, when constructed, will necessarily be of sufficient capacity to serve as an outlet for the drainage of the whole district as far north as the water-shed of Davenport Hill, west to the Northern Railway line, and eastward to Bathurst Street. It would be proposed to make it serve in addition as an outlet for the area drained by the University stream, and by extending the branch along Bloor Street to give an outlet for the sewerage of the greater part of Yorkville.

The main sewer would follow the general valley line of the stream from Bloor Street to the Cattle Market, thence to the west of the Old Fort, with its outlet outside the harbor west of the Queen's Wharf. Intercepting branches would be constructed along College Street and Bloor Street to the east and west.

As mentioned, the branch along Bloor Street to the east would cut off the University stream at Bloor Street, and being extended to Yonge Street would receive the sewerage from Yorkville by main sewers constructed along Avenue Road and Yonge Street.

The estimate for this work is as follows:

Main sewer on line of Garrison Creek to the lake.....	$226,000
Branch to the west along Bloor Street as far as the railway tracks..	76,000
Branch to the east along Bloor Street as far as Yonge Street.....	100,000

The accompanying plan shews the sewer and its branches.

The right of way which it would be necessary to acquire along the length of the main sewer could be converted at little expense into a very fine drive, and as has been shewn by the report of the Assessment Commissioner, the value of the Corporation property south of Queen Street would be increased in value at least one-half.

INTERCEPTING SEWER.

The plan proposed for the intercepting sewer along the front of the City provides for its being constructed of sufficient capacity to carry off the sewage proper, and a certain proportion of the rain-fall from the whole area of

the City now sewered and discharging into the bay, as well as from the area included in the Garrison Creek system. The sewage would be conveyed eastward to the west side of the Don, there to be passed through a set of chambers provided with suitable screens, with a view to the removal of all floating bodies and the settlement of the heavier suspended matter—the chambers being duplicate, with the object of enabling the examination and cleansing of one set whilst the others were in use. An overflow and discharging weir would be provided on the direct line of the sewer, by which the storm water, and, on occasion, the whole flow from the sewer, could be turned into the Don. Storm water overflows into the bay would also be provided at the points of intersection of the present sewers. From the chambers at the west side of the Don, the sewage would be conveyed under the bed of the stream to a chamber on the eastern bank; thence by a suitable conduit eastward through Ashbridge's Bay, to be finally disposed of by discharge into deep water in the lake opposite Scarborough Heights.

An approximate estimate of the cost of this work is as follows:

Intercepting sewer along the front of the City, from the Garrison Creek to the Don, with connections, overflows, etc.....	$292,000
Chambers at the Don, with pipe under the river.....	35,000
Conduit from the Don eastward across Ashbridge's Bay and out into the lake, as indicated on the plan.....	800,000
	$1,127,000

No special surveys have been made, except with regard to the sewer along Front Street, and this would have to be done before accurate plans and estimates could be prepared. Those submitted, however, are sufficiently accurate to give an approximate idea of the cost of this work.

In 1884 $100,000 was granted by the City for the construction of a portion of the Garrison Creek sewer, extending from College Street to the lake. This creek drains some 4,000 acres of land, and owing to the large quantity of sewage emptying into it, the creek had become very objectionable to those living in its vicinity. The construction of this sewer commenced in the summer of 1884, and is now completed. It was intended that this sewer should become a portion of a system of main sewers to be adopted at some future time by the City. Since coming into office I have kept this matter in view, and although no special appropriations have been made for this service, surveys have been made over a large portion of the City and the outlying townships for the purpose of coming to a decision as to the best manner of carrying out a system of main intercepting sewers, with an outfall into the lake at some distance from the City. The area to be drained when estimating the size of these sewers is 14,050 acres; of this amount 7,050 lie to the north of the City, in the Township of York, and 7,000 within the City limits.

In selecting a point on the lake shore for the discharge of the sewage, I have been induced to carry the outlet some distance further east than my

predecessors. My object in making this change is to remove the sewage to such a distance from the City and from the source of the water supply as to avoid a possibility of its return. The distance from the outlet to the crib at the water supply pipe is $6\frac{81}{100}$ miles. The sewage outlet lies south of the Scarborough Heights; it will empty into deep water, and will not, I think, be acted upon by any local currents, for although I have no positive information of the currents at this point, my assistant, Mr. Rust, during the fall of 1884, succeeded in putting in a few days' work, and placing a number of floats at the point where the discharge would be. Having no means to follow them in rough water, some were lost; a number, however, were successfully placed, with the result that only two of the number were carried westward; a strong easterly wind blowing at the time was the cause.

It is to be regretted that the small amount placed in the Estimates of last year for the purpose of carrying out this necessary work was thrown out; in the Estimates for this year I have again placed a sum for the same purpose, as no recommendation for an outlet sewer can be made until some positive information on this point is given.

The present populatinn of the City is from 120,000 to 130,000, scattered over a large area, the greater part of which is sewered. There are at present 115 miles of sewers of all descriptions laid down within its limits, the approximate cost of which amounts to $1,553,000. With the already large outlay, I take it for granted that no change will be made in the system of sewerage. There are 21,000 water services put in up to date, and they are increasing at the rate of 2,000 per year. The daily water delivery is not less than twelve million gallons, supplying 83,000 water takers, 42,000 being supplied from wells. There are 11,000 water closets, and 14,000 privies, a very large number of the latter being connected with the sewers. I have not gauged the sewers emptying into the Bay, and am unable to give the outflow, but from the quantity of water used and the flow of sewage, I believe I am below the average when I estimate the quantity at ten million gallons daily. The sewage is increasing in quantity and impurity, and although no apparent bad results have arisen from the foulness of the water in the Bay, (excepting the often stated impurities of the water supplied to the citizens), sufficient in itself to call for its immediate removal and final disposal to some point outside the City, and at such distance from its limits to insure freedom from any bad results. This calls for a change, and to relieve the Bay from this very objectionable outflow, and to provide a relief, I lay before your Committee two proposals for intercepting and outfall sewers, assuming that the flow from the place of discharge to be eastward and from the City.

The first proposal calls for two main intercepting sewers, one midway between the Bay and Bloor Street, on the line of Gerrard Stree; and on Front Street, from its connection with the Garrison Creek sewer, a short distance south of Wellington Avenue.

The Gerrard Street main intercepting sewer will take the drainage of all that portion of the City and Township lying north of the line of Gerrard Street,

and south of the creek known as Rosedale Creek, and east of Bathurst Street, an area of 1,640 acres. This main intercepting sewer is divided into four sections, as follows:

Section.	Area Drained in Acres.	Size of Sewer.
1.	440	3 ft. 2 in. x 4 ft. 9 in.
2.	900	4 ft. 0 in. x 6 ft. 0 in.
3.	1400	5 ft. 9 in. circular.
4.	1640	6 ft. 0 in. "

Its capacity is calculated for a rainfall of 2½ inches in 24 hours, less one-third loss for evaporation and absorption, and 8 cubic feet of sewage per head, with a population of 70 persons to the acre; the half of which will flow off in eight hours. The object in providing for so large a quantity of rainfall, is to relieve the main to the south from being overcharged. A bridge with flume for carrying the sewage will be erected at Gerrard Street, this flume will connect with the outfall sewer on the east side of the river, with a settling tank on the west side, into which the Gerrard Street sewer will discharge. To relieve the creek known as Rosedale Creek from the sewage of that portion of St. Paul's Ward north of the ravine and Rosedale, a 2 ft. x 3 ft. sewer will be constructed connecting with the Yonge Street sewer north of the ravine; this sewer will pass along the valley to Huntley Street bridge, where the size will be increased to a 2 ft. 4 in. x 3 ft. 6 in. From this point it will run to a connection with the settling tank at Gerrard Street.

All storm waters from this creek will pass through the present creek channel, and discharge as at present into the Don.

The Front Street main intercepting sewer will from its connection with the Garrison Creek pass through the lands of the Doty Engine Works to Front Street, along Front Street to Water Street, thence northerly, crossing some private lands, to the flats of the Don, and along the flats to Gerrard Street. This main intercepting sewer is divided into four sections, as follows:

Section.	Area Drained in Acres.	Size of Sewer.
No. 1	3,330	4 ft. 6 in. circular.
" 2	4,000	5 ft. 0 in. "
" 3	4,400	6 ft. 0 in. "
" 4	4,800	6 ft. 6 in.

The last section includes the tank sewer. The size of this sewer is estimated for a ¼ inch of rain in 24 hours, and eight cubic feet of sewage per head, with a population of 40 and 70 persons (according to the locality) to the acre of the area drained.

Storm overflows will be provided at the intersection of this main intercepting sewer with the several main sewers emptying into the Bay. It is not the intention to intercept any more than the ordinary flow of the Garrison Creek sewer; all storm water emptying into the Lake. A self-acting valve will be provided to carry this into effect. The Front Street sewer will also be carried along from Water Street to the Don to permit of the discharge of storm water.

On the north side of Gerrard Street a pumping station will be erected with engines to lift the sewage from the lower part of the City to the tank connecting with the outfall sewer. The capacity of these pumps will be twenty million gallons in twenty-four hours.

The outfall sewer from its connection with the flume on the east side of the river, will be carried along Gerrard Street to Pape's Avenue, and will thence curve southerly to the lake, descending into the lake, through the ravine west of Victoria Park. This sewer will be circular, nine feet in diameter, the total length being 20,400 feet. It will be connected with a receiving basin at the outlet, with an iron pipe six feet in diameter extending 3,500 feet into the lake, discharging the sewage at a depth of 34 feet below the zero level of the lake. This pipe will discharge 20,357 cubic feet per minute.

The following is the estimated cost of this work:

ESTIMATED COST

Of intercepting sewer along Front Street, from the Garrison Creek to connection with high level sewer at Gerrard Street bridge, distance, three $\frac{59}{100}$ miles.

Section No. 1:		
Garrison Creek to Bathurst Street	$14,275 00	
Section No. 2:		
Bathurst to Simcoe Street	47,068 00	
Section No. 3:		
Simcoe to Sherbourne Street	48,738 00	
Section No. 4:		
Sherbourne to Gerrard Street	81,267 00	
		$191,348 00
Tank sewer 1,000 feet long	$21,353 00	
Storm overflow along Front from Water Street to Don	15,300 00	
Valve head at Don and manholes	1,450 00	
Storm overflows	6,000 00	
Bellmouths	1,200 00	
Pipe sewer for drainage purposes	28,000 00	
		73,303 00
Total cost		$264,651 00

ESTIMATED COST

Of intercepting sewer along Nassau and Gerrard Streets, from Bathurst Street to the Don River—length, two $\frac{53}{100}$ miles.

Section No. 1:	
Bathurst Street to Spadina Avenue	$10,816 00

Section No. 2:		
Spadina Avenue to Terauley Street	$22,910 00	
Section No. 3:		
Terauley to Seaton Street	36,604 00	
Section No. 4:		
Seaton Street to Don	$39,360 00	
Tank at Don	10,000 00	
Bellmouths	2,000 00	
Overflows	4,800 00	
Pipe sewers for drainage purposes	35,736 00	
		$162,226 00

St. Paul's Ward, north of Creek and Rosedale, from Yonge Street to Gerrard Street bridge, distance one $\frac{93}{100}$ miles.

Estimated cost	$33,104 00	
		$ 33,104 00

Main outfall sewer, from Gerrard Street bridge to the Lake at Victoria Park distance, three $\frac{86}{100}$ miles.

Estimated cost	$374,453 00	
Culverts for creek crossings	2,880 00	
Crossing Small's Pond	2,000 00	
Outlet into Lake	67,500 00	
Connecting chamber	1,000 00	
		447,833 00
Cost of engines, boilers, coal shed, boiler room, &c.	$62,600 00	
Engine house, including all connections with sewers, &c.	50,000 00	
Penstock, with gates, &c.	4,000 00	
Engineering and contingencies	5,000 00	
		121,600 00
Bridge over Don at Gerrard Street—masonry	$40,000 00	
Superstructure, with flumes for carrying the sewage	35,000 00	
		75,000 00
Damage to water and gas mains	$ 10,000 00	
Land for engine house and tank	25,000 00	
Land damages	100,000 00	
Lumber for shoring, &c	50,000 00	
		185,000 00

SUMMARY OF COST.

Front Street sewer:	
Garrison Creek to Don at Gerrard Street	$ 264,651 00
Nassau and Gerrard Street	162,226 00
St. Paul's Ward and Rosedale	33,104 00

Main outfall sewer	$ 447,833 00
Engines, boilers, engine house, &c	121,600 00
Bridge over Don at Gerrard Street	75,000 00
Damage to water and gas mains	10,000 00
Land for engine house and tank	25,000 00
Land damages	100,000 00
Lumber	50,000 00
	$1,289,414 00
Contingencies	128,941 00
Total	$1,418,355 00

The necessity for pumping a portion of this sewage will entail an annual expenditure, estimated at $43,445.00, as follows:

Coal	$35,680 00
Oils	1,825 00
Wages, Engineers	2,190 00
Engineer in charge	1,200 00
Firemen	1,800 00
Sundries	750 00
	$43,445 00

Intercepting Sewer along Gerrard and Nassau Streets, from Bathurst street to River Don; 2½″ of rain in 24 hrs., of which ⅔ will reach the sewer; sewage 8 cubic ft. per head; 70 persons to the acre; ½ to flow off in 8 hours.

Section.	Area drained, in acres.	Cubic ft. of sewage per minute reaching the sewer.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in feet per minute.		Grade.
				Full.	⅔	Full	⅔	
			′ ″ ′ ″					
Bathurst to Spadina..	440	2112	3 2 x 4 9	3363	2312	292	305	1 in 400
Spadina to Teraulay..	900	4320	4 0 x 6 0	6064	4160	329	344	"
Teraulay to Seaton....	1400	6720	5 9 circ'r	9857	7250	372	394	"
Seaton street to Don..	1640	7872	6 0 "	10,603	8100	375	405	"

Intercepting Sewer along Front Street and the Don, from Garrison Creek to Gerrard Street Bridge; ¼″ rain in 24 hrs., 6 and 8 cubic ft. of sewage per head, and 25 and 70 persons to the acre; ½ to flow off in 8 hours.

Section.	Area drained in acres.	Cubic ft. of sewage per minute reaching the sewer.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in feet per minute.		Grade.
				Full.	⅔	Full	⅔	
Garrison Creek to Bathurst.....	3330	2617	′ ″ 4 6 circ'r.	3213	2475	202	220	1 in 1000
Bathurst to Simcoe...	4000	3215	5 0 "	4182	3225	213	232	"
Simcoe to Sherbourne	4400	3600	6 0 "	6616	5100	234	255	"
Sherbourne to Gerrard Street Bridge.	4800	3965	6 6 "	8097	6874	244	284	"

Main outfall sewer, from Gerrard Street Bridge to Lake, at Victoria Park :

Section.	Area drained in acres.	Cubic ft. of sewage per minute reaching the sewer.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in feet per minute.		Grade.
				Full.	⅔	Full	⅔	
Gerrard Street to Lake	12,476	14,983	′ ″ 9 0 circ'r.	18,385	14,130	289	314	1 in 1000
			"	26,083	19,935	410	443	1 in 500

Rosedale and St. Paul's Ward, north of creek—Yonge Street to Gerrard Street Bridge, ¼″ rain in 24 hours; 25 persons to the acre; 8 cubic feet per head; ½ to flow off in 8 hours.

Section.	Area drained in acres.	Cubic feet of sewage reaching the sewer per minute.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in feet per minute.		Grade.
				Full.	⅔	Full	⅔	
Yonge to Gerrard St. Bridge.....	936	800	′ ″ ′ ″ 2 0 x 3 0	1511	1270	329	344	1 in 200
			2 4 x 3 6	1676	1152	268	280	1 in 350

The large annual expenditue which would be immediate on the operation of the first proposal, leads me to lay before the Committee a second proposal; this is the construction of a main intercepting sewer along the line of Queen Street, carrying the ordinary flow from all the lands north of Queen Street, and extending from Roncesvalles Avenue (the west limit of the town of Parkdale), embracing an area of nearly 6,000 acres. This sewer to carry, when running two-thirds full, one-quarter inch of rainfall in 24 hours, and eight cubic feet of sewage per head from a population of 25 and 70 persons to the acre, one-half of which will enter the sewers in eight hours. This sewer will tap the Garrison Creek at Queen Street, extending along Queen Street to the Don, and passing under the river by a syphon 7 feet in diameter, and connecting with the outfall sewer, which will be continued along the line of Queen Street to a connection with the outfall sewer of the first proposal; and entering the lake at the same point, and as mentioned in the first proposal, will empty into the lake by an iron main 6 feet in diameter, 3,500 feet long, into a depth of water of 34 feet below zero.

The length of the outfall sewer, from the Don to the lake, is 20,200 feet. The first section will extend from the Don to the railway crossing, 2,200 feet in length (circular sewer). The length of the second section will be 8,900 feet, and, owing to the surface of the roadway being very low through this section, the form of the sewer must be changed. The height from the invert to the soffitt of the arch will be 6ft. 6in., and the width 15ft.; this will allow four feet of material to be placed over the work, sufficient to protect it from the frost. The third section, 9,100 feet in length (circular), will extend to the lake.

This sewer can at any future time be extended westerly to the west limit of the town of Parkdale.

The following are the different sections, shewing the area drained, with the size of sewer proposed:

Section.	Are drained in acres.	Size of sewer. ft.	in.	
No. 1.	3,330	5	6	circular.
" 2.	4,412	6	0	"
" 3.	5,332	6	6	"
" 4. (to the Don)	5,795	7	0	"
Don to railway crossing	8,200	9	0	"
Railway to Woodbine.....	12,000	6	6 x 15 ft. Segment.	
Woodbine to lake	14,050	9	6	circular.

A second main intercepting sewer will be laid down along Front Street. This sewer will tap the Garrison Creek a short distance south of Wellington Avenue, and will pass through the lands of the Doty Engine Works to Front Street, and from thence along Front Street to the Don, passing under the river by a second syphon, from whence the sewage will be raised by pumping some ten feet to a main, from which it will flow by gravitation to the outfall

sewer. This will also provide a means of draining all the lands south of Queen Street, east of the Don, relieving Ashbridge Bay from the discharge of the byres and piggeries and any other works of a like description which no doubt will be carried on in this district.

The cost of pumping a portion of this sewer will entail an annual expenditure estimated as follows:

Coal	$20,000 00
Oils	900 00
Wages, Engineers	1,700 00
" Firemen	1,000 00
Engineer in charge	1,200 00
Sundries	1,000 00
	$25,800 00

The total estimated cost of the second proposal will be $1,443,483.00, as follows:

Estimated cost of intercepting sewer on Queen Street, from Garrison Creek to lake at Victoria Park, distance $6\frac{79}{100}$ miles:

Section No. 1:		
Garrison Creek to Bathurst	$ 43,060 00	
Section No. 2:		
Bathurst to Simcoe	109,256 00	
Section No. 3:		
Simcoe to Sherbourne	106,277 00	
Section No. 4:		
Sherbourne to Don	66,331 00	
Overflows and bellmouths	12,000 00	
		$336,925 00
Syphon under Don	$15,596 00	
Connecting chamber, screens, &c	20,000 00	
		35,596 00
Outfall sewer from Don to lake at Victoria Park:		
Section No. 1:		
Don to Railway crossing	$ 30,034 00	
Section No. 2:		
Railway crossing to Woodbine	294,308 00	
Section No. 3:		
Woodbine to lake	204,403 00	
		$528,745 00

Outlet into lake	$67,500 00	
Connecting chamber	1,000 00	
		$68,500 00
Rosedale and St. Paul's Ward, north of creek, from Yonge Street to Don, at Queen Street	$39,510 00	
		39,510 00

Estimated cost of sewer along Front Street, from Garrison Creek to Don, at Queen Street, distance 3 $\frac{13}{100}$ miles:

Section No. 1:		
Garrison Creek to Simcoe	$30,248 00	
Section No. 2:		
Simcoe to Jarvis	18,322 00	
Section No. 3:		
Jarvis Street to Don	36,612 00	
Overflows and bellmouths	7,700 00	
		92,982 00
Engines, boilers, &c., complete	$50,000 00	
Land, engine-house, screens, connection, &c	50,000 00	
		100,000 00
Damage to water and gas mains	$10,000 00	
Land damages	50,000 00	
Lumber	50,000 00	
		110,000 00

SUMMARY OF COST.

Queen Street sewer:

Garrison Creek to Don	$336,925 00
Syphon, connecting chambers, &c	35,596 00
Queen Street, Don to lake	528,745 00
Outlet into lake and connecting chamber	68,500 00
Rosedale and St. Paul's Ward	39,510 00
Front Street sewer	92,981 00
Engines, boilers, engine-house, land, screens, connections, &c	100,000 00
Damages to water and gas mains	10,000 00
Land damages	50,000 00
Lumber	50,000 00
	$1,312,258 00
Engineering and contingencies	131,225 00
	$1,443,483 00

Intercepting sewer along Queen Street, from connection with the Garrison Creek sewer to the lake at Victoria Park; $\frac{1}{4}$in. rainfall in 24 hrs., and sewage varying from 25 to 70 persons to the acre, and 6 to 8 cubic feet per head, the $\frac{1}{4}$ to flow off in 8 hours.

No.	Section.	Area drained in acres.	Cubic ft. of sewage per minute reaching the sewer.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in cub. ft. per min. running.		Grade.
					Full.	⅔	Full	⅔	
1	Garrison Creek to Bathurst	3330	2764	5′ 6″ cir.	3,777	2,890	155	172	1 in 2,000
2	Bathurst to Simcoe	4412	3803	6′ 0″ "	4,722	3,600	162	180	"
3	Simcoe to Sherbourne	5332	4686	6′ 6″ "	5,774	4,418	169	188	"
4	Sherbourne to the Don	5795	5130	7′ 0″ "	6,966	5,285	176	194	"
5	Don River to Railway Crossing	8200	7468	9′ 0″ "	12,787	10,305	201	229	"
6	Railway Crossing to Woodbine	12000	10108	6′ 6″ x 15′ 0″ (segments)	12,760	10,476	181	194	"
7	Woodbine to Lake	14050	11472	9′ 6″ cir.	14,673	11,386	207	227	"

Intercepting sewer along Front Street, from the Garrison Creek to the Don, at Queen Street; ¼″ rain in 24 hours, and 25 and 70 persons to the acre, using 8 cubic feet per head, ⅓ to flow off in 8 hours.

No.	Section.	Area drained in acres.	Cubic ft. of sewage per minute reaching the sewer.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in ft. per min. running.		Grade.
					Full.	⅔	Full	⅔	
1	Garrison Creek to Simcoe	839	805	2′ 8″ x 4′ 0″	1,348	930	165	175	1 in 1000
2	Simcoe to Jarvis	1000	1003	2′ 10″ x 4′ 3″	1,567	1,086	173	179	"
3	Jarvis to Don	1189	1191	3′ 2″ x 4′ 9″	2,073	1,160	189	180	1 in 1500

Rosedale and St. Paul's Ward, north of Creek; Yonge Street to Queen Street, at Don River; ¼" rain in 24 hours; 25 persons to the acre; 8 cubic feet per head, ½ to flow off in 8 hours.

Section.	Area drained in acres.	Cubic ft. of sewage reaching the sewer per minute.	Size of Sewer.	Capacity in cubic feet per minute running.		Velocity in ft. per min. running.		Grade.
				Full.	½	Full	½	
Yonge to Queen.....	936	800	2′ 0″ x 3′ 0″	1,511	1,270	329	344	1 in 200
			2′ 4″ x 3′ 6″	1,676	1,152	268	280	1 in 350

In the first proposal, the sewage from a portion of the land lying south of the outfall sewer will be carried to this outfall by means of an intercepting sewer laid south of the Kingston Road (Queen Street), and will be connected with the outfall near its entrance to the Lake. This is a matter that calls for no special notice at present, and which can be dealt with at any time when the demand for drainage of this portion of the City is called for. In the second proposal it will be necessary to lift the sewage from that portion of the City south of Queen Street to a higher level, a large portion of this district being at present waste lands. The quantity of sewage from it will be small in comparison to the whole, and should it be deemed advisable, can be emptied into the river for some time without affecting the health of the citizens or polluting the water supply. The proposal laid before the Committee will provide drainage for a population of 400,000 persons, and the system can be extended to meet further requirements when necessary. Should it be desirable at any time to lessen the flow into the Garrison Creek sewer a sewer could be laid down on the line of the Davenport Road, intercepting the drainage of a large portion of the County, and relieving to a great extent the second or low level intercepting sewer which connects with the Garrison Creek sewer south of Wellington Avenue. The various creeks crossed by the outfall sewer will not be connected, but will pass underneath, provision having been made in the estimate for the construction of the culverts at these points; the rainwater flowing into the creeks as at present. In all large cities similarly situated, the same method of disposal of the sewage as proposed for this City is carried out; that is, by emptying the sewage into deep water; on the sea coast the sewage being discharged at a certain state of the tide, and carried by the ebb seaward. Cities situated on the large lakes, as we are, discharge their sewage into deep water in the lake If after a careful examination it can be proved that the sewage will not return towards the City from the place of the proposed discharge into the lake, then this will be the most satisfactory and least

expensive method of disposal; but should it be shewn that this is not the case, then some other method must be provided. Many means are employed to effect this precipitation by means of chemicals, filtration, by mechanical and natural means, and irrigation. This latter method is adopted in many of the towns in England with great success.

Intermittent filtration may be employed, and I believe with success, and probably with the least expense. Mr. Bailey Denton, in his ten years' experience of intermittent filtration, mentions a number of towns in which the sewage is treated in this way, with populations from 3,000 to 50,000. In describing Merthyr Luydfil, in South Wales, he says that "for five months the sewage equivalent to that of 25,000 persons was put on 20 acres, and was effectively clarified." Mr. Harper, surveyor of the district, in evidence given before the River Pollution Commission, 1872, in answer to the question, Did you notice, when the whole of the sewage was being passed on to the 20 acres, any tendency for the land to choke? Ans.—No. And in answer to the question, Suppose you decided upon sacrificing the vegetation, what would your opinion be? Ans.—Then I think we might cleanse the whole sewage of the town. That is a population of 50,000 on 20 acres. This land was under crop at the time.

Sir Robt. Rawlinson, Chief Engineering Inspector to the Local Government Board, in his suggestions, states: "The areas which have been found in practice to answer are as understood, namely, for broad irrigation, about one acre to each 100 of population of a fully water-closeted town. Where tanks separate solids, and fluid is clarified by chemicals, one acre of land prepared as a land filter may serve for 500 of a population."

The following table is from a report of Mr. Samuel M. Gray, on a proposed sewerage system for the City of Providence, R.I.:

Town.	Population.	Disposal of sewage.	Area of land to which sewage is applied.	Condition of effluent.	Dry weather flow of sewage per day, imperial gallons.	Number of population of Town to one acre of sewage land.
Birmingham, Eng.	420,000	Precipitation and irrigation.	500 acres now being used and will shortly be increased to 1,900.	Good, very clear.	13,000,000	.....
Crowdon, "	80,000	Run on land and surface irrigation.	450 acres.	Good.	4,700,000	144
Oxford, "	41,000	Irrigation farm and intermittent filtration.	.....	Very good.	1,250,000	128
Wimbledon, "	20,000	Chemically treated and then run over land.	395 acres.	Good.	560,000	328
Breslau, Germany.	300,000	Irrigation.	741 acres now being used, and 1210 additional in preparation.	.....	7,707,000	400
Dantzic, "	109,600	Irrigation.	395 acres now in use, and 296 additional available.	.....	3,063,700	250

The amount of land at Breslau will soon be increased to about 2,000 acres.

The soil at Dantzic is extremely porous.

At Wimbledon the solids are extracted from the sewage by the action of lime, only the effluent being applied to the land.

In reference to the disposal of sewage, I have appended extracts from a report of Mr. Eliot C. Clarke on the drainage of the valleys of the Mystic, Blackstone, and Charles River, Mass, to which I would respectfully call your attention. I have also placed in the appendix extracts from report of Mr. Wm. Laut Carpenter in *re* test of water in the bay.

Test 13, made at bell buoy, the entrance to supply pipe, 2,000 feet south of the Island, in which he states the water is contaminated to a certain extent, as this test was made by comparison with distilled water, it would have been well if Mr. Carpenter had made one more test some distance south of the buoy, where the water would be normally pure. It is very probable that the difference would have been imperceptible.*

Test 12-15 leans me to the belief of two currents from the bay, one to the west through the Queen's Wharf channel, and one southerly through the Gap.

Referring to Mr. Carpenter's 4th clause, I may say the remedial measures have been taken, and all leaks into the main between the Bell buoy and the supply main to the pumps at the Engine House are a thing of the past, and the water now supplied the citizens is direct from the source of supply at the Bell buoy.

All of which is respectfully submitted.

CHAS. SPROATT,
City Engineer.

* Since writing this Report I am informed by the Medical Health Officer, Dr. Canniff, that he, accompanied by the Chairman of the Water Works Committee, Mr. Walker, made tests, first at the Bell buoy, and at 1, 2, and 3 miles south of the Bell buoy, and found no difference in the samples.

APPENDIX

A.—Extract from the *Patriot* newspaper, 1853, *re* the harbour.

B.—Report by Mr Wm. Laut Carpenter, B.A., B.Sc., F.C.S., on the water of the Bay.

C.—Extract from a Report of Prof. Macadam on the disposal of sewage.

D.—Extracts from Report of Mr. Eliot C. Clarke, Engineer, to a commission to consider a general system of drainage for the valleys of the Mystic, Blackstone and Charles Rivers, Mass.

E.—Table of rainfall, from the Reports of the Toronto Meteorological Observatory

F.—Report of Mr. Rust, on Float Experiments.

APPENDIX A.

On looking over some numbers of the *Patriot* newspaper for 1853, I find that a discussion on this subject, with others, in *re* the harbour, took place at that date. Among others, I find Mr. Kivas Tully taking part in the discussion, and in a letter to the editor, he, in reference to the alluvial from the River Don, agrees with a preceding writer that "the greater portion (of the matter) remains in the harbour, which becomes a cesspool for such deposit," (he approves of the word cesspool,) "as it is a receptacle for other deposits besides," that is from the outflow from sewers and their freight. In this communication Mr. Tully makes a recommendation "That a covered channel, ten feet in width and six feet in height, should be constructed in the centre, and beneath the intended Esplanade, from the River Don to the Queen's Wharf. The drains of the City to be extended to this channel, and a portion of the current of the River Don to be turned into it by daming the present channel and allowing the surplus water to flow into the marsh as at present over a waste weir one foot in height above the present level of the water.

Extract from a letter from Mr. Kivas Tully to J. G. Booz, Esq., August 26th, 1853:

"I would urge the necessity of some means being taken to carry away the outflow from the sewers, to prevent the deposit in the slips 'where they empty themselves.' * * * Some provision must be made for remedying this increasing evil; otherwise, the health of the citizens will be endangered The evil is really great, even now. * * * What will it be when the City numbers 100,000 inhabitants? Provision should therefore be made conjointly with the construction of the Esplanade."

APPENDIX B.

Report by Wm. Laut Carpenter, Esq., B. A., B.Sc., F.C.S., dated September 20th, 1884, addressed to Aldermen McConnell, Walker, and Hunter, members of the Water Works Committee:

"The method of testing consists in the employment of a chemical salt called permanganate of potash. * * * Being unprovided with the necessary apparatus which I usually employ for exact work, I could only make it in its rough form yesterday, and judge of the water by the color test, keeping pure distilled water as a standard.

SAMPLES.

1. Foot of West Market Street.
2. Foot of Berkeley Street, near the mouth of the Don.
3. Foot of Yonge Street.

4. Foot of Simcoe Street.

All these were strongly charged with organic matter; No. 2 being decidedly the worst of all, and the others being in the order of badness 3, 4, 1.

5. Over pipe between pumping house and block house bay, one-third the way across.

6. Block house bay, two-thirds the way across.

These were better than the first four, and No. 6 better than 5.

7. Manhole at Hanlan's Wharf.

8. Crib in block house bay, whence for two years the City water was drawn.

Very little difference in these, but they were distinctly worse than 13—bell buoy.

9. Inside iron cage at Pump House Wharf.

10. Outside iron cage at Pump House Wharf.

Very little difference between 9 and 8, but a decided difference between 9 and 10; No. 10 was much inferior but possibly on account of suspended matter in the sample caught.

11. Well in pumping house.

About equal to Nos. 7 and 8, but decidedly not so good as 13—water at bell buoy.

12. Midway between the shore at Berkeley Street and the east gap.

Very bad water, nearly as bad as samples 1 to 4.

13. At bell buoy.

Decidedly the best sample of all, but did not compare well with pure water. This is without doubt contaminated to a certain extent.

14. Garrison Creek west of Queen's Wharf.

Very fair; about equal to No. 8.

15. In the channel off Queen's Wharf.

Badly contaminated like No. 1.

From the result of these tests, and from all the information which I was able to gather with regard to the general movement of the lake water, the character of your engineering works, the general disposition of your sewage, &c., I am disposed to conclude:

1. That the whole of the water in your bay is more or less contaminated with organic matter, and probably in a degree dangerous to health.

2. That the worst water flowing into the bay is at the east end, in the neighborhood of the Don, and that this is specially dangerous, as the general drift or movement of the water, as far as I can learn, is from that quarter towards the City.

3. That the water as drawn from the bell buoy is by no means free from contamination by sewage and other organic impurities.

4. That this water becomes mixed in its passage from the bell buoy to the pumping house with the bad water in the bay, probably from leaks in the pipes and in the well at the lake end of the wharf of the pumping house.

It is quite possible that further wo k on my part might cause me to modify some of my conclusions, and it would certainly enable me to give more exact results. I have, however, no doubt whatever in my own mind of their general correctness. * * * A town may go on for some time drinking contaminated water with apparent freedom from illness, but this water is the breeding ground for many germs or microbes, and experience has shown that the intestinal discharges of one typhoid fever patient into such water is sufficient to poison a large water supply, so rapidly do the germs multiply under favorable conditions.

APPENDIX C.

Extract from Professor Macadam's Report to the Hon. Alexander Morris, read by His Worship the Mayor to the Council, September, 1884:

"The present mode of the disposal of the sewage is extremely primitive, and independently of the pollution of the water supply, must be immediately dealt with At present the bay is becoming grossly polluted, and the putrescent debris must evolve noxious gas and organisms, to the serious impregnation of the atmosphere of the City The continuance of the discharge of the sewage of the City along the foreshores should therefore not be allowed. The remedial work should include a main intercepting sewer which would convey the sewage some distance out of town, and the sewage should then be pumped up over land of a sandy and gravelly nature by the process of intermittent downward filtration, whereby the sewage is deprived of its noxious elements, and the land can be utilized for the growth of crops. This system is in successful operation in various parts of Great Britain."

APPENDIX D.

Extract from Report of Mr. Eliot C. Clarke, Engineer to a Commission appointed to consider a general system of drainage for the valleys of the Mystic, Blackstone and Charles Rivers, Mass.:

TURNING CRUDE SEWAGE INTO WASER.

Sec. 94. Until recently this method of disposal was universally adopted, and it is still the common one everywhere except in England. Its merits can be ascertained by observing how it has worked in a large number of cases under different conditions.

Sewage is water containing putrescible matter in solution and also solid putrescible particles in suspension. The solid particles are kept in suspension by the motion of the water flowing in the sewers. If the sewage is emptied into a current of water at the rate of about a mile an hour, or faster, most of the solid particles will remain in suspension until they reach places where the water is comparatively still, when they gradually settle to the bottom, the heaviest particles sinking first. If the particles as they settle are widely scattered over a large area, their putrescible constituents will soon be oxidized so that they will not create any nuisance. But if the particles settle in masses, the lower ones being kept from contact with the oxygen in the water will decompose, slowly giving off offensive gases.

Sewage water mixes readily with the clean water into which it is discharged, and the organic matter in solution is thereby diluted. If the dilution is very great say twentyfold or more, no subsequent putrefication is noticed, and the organic matter is oxidized by the oxygen in the water with which it is diluted.

Two conditions are necessary therefore to insure that crude sewage when put into water shall not cause a nuisance: First, there must always be enough water to dilute very greatly the matter in solution, and second there must be a constant current which shall carry away and widely disperse all the suspended particles. It is more rarely than might be supposed that these two conditions are found to exist. A stream may usually have amply enough water to dilute a sewage discharge, but during occasional droughts it may prove to be insufficient. The current of a river may be generally sufficiently rapid but have places where there is a slack water or eddies in which suspended particles deposit. A portion of the sewage is apt to work into the edges of a current or near the shore where there is little motion.

CLARIFICATION BY THE USE OF PRECIPITANTS.

Sec. 96. Although it is impracticable to extract the solid particles by simple subsidence, or by the use of artificial filters, clarification can be accomplished by adding a precipitant to the sewage before it enters the settling tanks. This mode of treatment has been adopted by about fifty cities and towns in England. A great variety of precipitants have been used; the two most generally employed, and the least expensive, are lime and sulphate of alumina. The former of these two is much the cheaper, and as the results obtained with it seem to be about as satisfactory as those where more expensive chemicals are used, it is generally employed for the purpose, either alone or in combination with a small quantity of other chemicals. To clarify ordinany town sewage about one ton of lime is necessary for each million gallons of sewage. Ordinary quick lime such as is used for buildings is employed. A rich, fat lime is to be preferred. The lime is first slacked by adding to it an equal weight of water. It is then ground as small as possible in a small pug-mill, a little water being added during this process. The paste is then mixed with more water, producing a cream of lime like ordinary whitewash. This is added to the sewage in a well in which are

revolving paddles called agitators, by which the lime and sewage are thoroughly incorporated, thence the sewage flows to the settling tanks. Within a few minutes after the addition of the lime a floculent precipitant is seen to form throughout the body of the sewage and to sink rapidly to the bottom of the tank. If the tank after being filled is left at rest for half an hour the precipitate will have all settled to the bottom, and the supernatant liquid can be drawn off entirely clear, with the exception of a little scum which may be floating on the surface. To carry out this process requires the use of a number of tanks, so that while some are filling others may be at rest and still others emptying. One or more attendants are needed to divert the sewage from one tank to another and to open and close as required the valves connecting with them. To avoid the necessity of such supervision, a modification of the process is more commonly used. By this the sewage, after the precipitant has been added to it, flows continuously through a series of tanks. These tanks are built so large that the sewage is several hours in passing through them, and its motion is so slow as to interfere but slightly with the subsidence of the precipitate, so that little if any of it flows off with the effluent. The tanks are so arranged that any one of them can be isolated for the removal of the sludge contained by it. In round numbers about one ton of semi-fluid black mud will be precipitated from each 50,000 gallons of sewage of the average character found in American towns. This sludge contains about 90 per cent. of water and is somewhat difficult to dispose of. In some cases it is pumped on to porous land, where the water drains or evaporates out of it until it is hard enough to handle, when it is either dug into the ground or carted away. In other cases it is passed through presses of peculiar construction which reduce it to about one-fifth of its former bulk and leave it the form of cakes containing about 50 per cent. of moisture and of the consistency of damp clay. The product in either case is almost valueless and it is rarely that farmers are willing to carry it away.

As will readily be perceived from the foregoing brief description, sewage precipitation requires a somewhat expensive plant and force of workmen to carry it on properly. Often it is necessary to elevate the sewage by pumping. There must be buildings to contain the engines, boilers, grinding mills, agitators, presses, pumps and other machinery. Two sets of workmen are needed, one for the day and the other for the night, and very intelligent supervision is required. As a rough approximation, the yearly cost of this process in England is about 37 cents per individual of the population whose sewage is treated.

Owing to the high cost of labor and materials in this country, the expense here would probably be double that in England. The daily wages of an ordinary laborer at the English sewage works rarely exceeds, if it reaches, three shillings per day, or about half what would be paid here. On this basis of computation, the expense to a city of 50,000 inhabitants treating its sewage by this method would be about $37,000 yearly.

Sewage is not purified by any process of precipitation. It is, indeed, only partly deodorized and is of course not fit to go into any stream used as a source of water supply. As much more thorough purification at less expense can be obtained by filtering through land, a precipitating process could be recommended only where the effluent could be discharged into water not used as a source of water supply, and where it is impracticable to obtain suitable areas of land for its purification.

PURIFICATION BY LAND.

By applying sewage to land it can be purified, both from its suspended impurities and from those in solution, and in the present state of sanitary science this is the only practicable way in which the latter purification can be effected. By this method the particles in suspension are removed by filtration, and the soluble impurities are oxidized by being brought into contact with the air contained in the earth. As stated in Sec. 95, it is impracticable to filter sewage thoroughly through artificial filters, because if any such filter is fine enough to arrest the fine particles these very soon clog its surface. The reason the land filter is not clogged is because it is so large. In the case of the artificial filter, an area of land when used for this purpose constitutes a very fine filter and retains the solid particles upon its surface. In the case of the artificial filter a ton of mud may accumulate upon 50 square feet of surface, whereas, with the land filter the same amount will be distributed over, say, 100,000 square feet. After depositing its sediments the sewage water slowly soaks into the ground. One-quarter part or more of the bulk of any porous earth consists of voids containing air. A part of the sewage water is evaporated from the soil, and the rest, as it sinks, spreads over every particle of earth in a thin film, and is thus brought in contact with the air in the ground. If 20,000 gallons of sewage filter evenly through an acre of land, where the ground water stands six feet below the surface, each gallon of sewage will be brought in contact with at least twenty-five times its bulk of air. The effects of this is to oxidize and change the organic impurities into harmless compounds, so that the effluent water, so far as can be determined by the senses and by chemical tests, is inoffensive and innoculous.

The essential requirement for this treatment therefore is a large area of porous land in which the ground water stands at least six feet below the surface, either from natural causes or on account of artificial drainage. The land must be reasonably flat in order to avoid great expense in preparing it to receive the sewage, and if it is so low that the sewage will flow to it by gravitation the expense of pumping will be avoided. Land on which sewage is purified need not cause any nuisance. Earth is a good deodorizer, and prevents the particles which lodge upon its surface from becoming offensive. It would be too much to say that no smell at all would ever be noticed from such land. On muggy days, when odors from all sources are most noticed, a slight one will prevail over even a well managed sewage farm; but there is no record of sickness being caused by this. At one sewage farm in England there are seventy children living in cottages entirely surrounded by irrigated

land. They are said to be in excellent health, and certainly look so. Very little prejudice is now felt in England against the proximity of sewage farms, and such farms are frequently established in the immediate vicinity of thickly settled residential parts of towns.

Apprehensions are sometimes expressed that the severity of the winters in our States might interfere with land filtration at that season. No trouble has ever been experienced from this cause. Sewage is so warm that it keeps the earth to which it is applied from freezing, or thaws it if already frozen. The winters at Pullman are colder than in most parts of Massachusetts, but irrigation has always proceeded there without interruption. I made a visit to that farm in February, 1885. For the five days previous the mercury had not risen to 0° Fahrenheit, and had been as low as 25°. On the day of my visit, the mercury standing at 12°, I found the sewage going on to the land, and covered by a stratum of ice from one to eight inches thick. I broke the ice, and with a spade dug a hole in the ground below, which was perfectly open. As the weather moderated the sewage rapidly melted the ice above it.

CONCLUSIONS.

Sec. 102. The proper disposal of sewage is always a difficult and expensive matter.

The least expensive method is to turn crude sewage into water, but this should not be permitted if the water is liable to be used for domestic purposes. In any event there must be at all times enough water to dilute the sewage twenty fold or more, and a current which will carry all of the suspended particles to a distance and distribute them widely.

It has not been found practicable thoroughly to clarify sewage by passing it through settling tanks or artificial filters.

Sewage may be clarified by chemical precipitation, but will not by such means be rendered fit to go into water used for domestic purposes, or into any water course where it will not be always greatly diluted. Such treatment could be recommended only where land purification was impracticable.

The only practicable method yet discovered of purifying sewage is by its intermittent application to large areas of land. The purification will be more effectually and more easily accomplished when the land is devoted solely to this purpose.

Excrement may be satisfactorily disposed of by the application of dry earth to it. This treatment may often prove useful, but is not of general application, and effects but slightly the question of sewage disposal.

Where sewage is to be treated in any way it is better to keep it separate from the rainfall in a distinct system of sewers.

APPENDIX E.

Number of inches of Rain and Snow for each month, from 1863 to 1871; an inch of snow taken to equal $\frac{1}{10}$ in. of rain. Taken from Reports of the Toronto Meteorological Observatory:

Year.	Month.	Inches.	Year.	Month.	Inches.
1863	January	3·182	1866	November	3·183
"	February	3·650	"	December	4·340
	March	1·827	1867	January	4·200
"	April	2·370	"	February	2·668
"	May	3·373	"	March	3·957
"	June	1·662	"	April	2·867
"	July	3·408	"	May	3·220
"	August	3·208	"	June	0·885
"	September	1·235	"	July	1·965
"	October	2·522	"	August	2·440
"	November	3·666	"	September	1·226
"	December	3·670	"	October	1·970
1864	January	3·795	"	November	1·925
"	February	1·347	"	December	2·768
"	March	1·990	1868	January	1·460
"	April	3·983	"	February	3·320
"	May	4·070	"	March	3·080
"	June	0·570	"	April	1·520
"	July	1·332	"	May	7·670
"	August	5·060	"	June	2·217
"	September	2·508	"	July	0·510
"	October	3·321	"	August	1·562
	November	4·215	"	September	4·329
"	December	4·755	"	October	1·565
1865	January	1·920	"	November	5·580
"	February	2·490	"	December	1·555
"	March	4·940	1869	January	1·867
"	April	4·172	"	February	4·135
"	May	4·005	"	March	2·485
"	June	2·005	"	April	3·015
"	July	2·470	"	May	2·805
"	August	1·990	"	June	4·373
"	September	2·450	"	July	4·610
"	October	3·155	"	August	4·273
"	November	1·085	"	September	4·027
"	December	2·247	"	October	1·192
1866	January	1·552	"	November	3·560
"	February	2·520	"	December	3·300
"	March	2·635	1870	January	5·542
"	April	1·675	"	February	2·530
"	May	2·820	"	March	6·995
"	June	2·720	"	April	2·155
"	July	5·390	"	May	1·150
"	August	4·457	"	June	8·090
"	September	5·657	"	July	1·896
"	October	2·670	"	August	3·442

APPENDIX E.—*Continued.*

Year.	Month.	Inches.	Year.	Month.	Inches.
1870.....	September	6·794	1871.....	May	2·302
"	October	2·690	"	June	3·340
"	November.....	0·904	"	July	1·255
"	December	4·020	"	August.....	2·800
1871.....	Januury.....	5·224	"	September	1·290
"	February.....	2·340	"	October	1·185
"	March	4.082	"	November.....	3·105
"	April	3·448	"	December	2·360

Table of Rainfall, from the Reports of the Toronto Meteorological Observatory.

Average Depth of Rain in inches in each year from 1840 *to* 1883.

Year.	Inches.	Year.	Inches.
1840.....	29·575	1862.....	25·529
1841.....	36·670	1863.....	26·483
1842.....	42·790	1864.....	29·486
1843.....	43·555	1865.....	26·599
1844.....	.....	1866.....	34·209
1845	.....	1867.....	19·041
1846.....	32·355	1868.....	26·408
1847.....	31·960	1869.....	31·182
1848.....	22·205	1870.....	33·898
1849.....	32·215	1871.....	22·771
1850	28·430	1872.....	18·588
1851.....	26·875	1873.....	20·232
1852.....	31·405	1874.....	17·574
1853.....	23·550	1875.....	18·980
1854.....	27·765	1876.....	21·063
1855.....	31·650	1877.....	21·885
1856.....	21·505	1878.....	43·390
1857.....	33·205	1879.....	2..·515
1858.....	28·057	1880.....	30·922
1859.....	33·274	1881.....	21·138
1860.....	23·434	1882.....	20·587
1861	26·995	1883.....	25·734

APPENDIX E.—*Continued.*

Greatest depth of Rain which fell in a single day from 1840 *to* 1871.

Year.	Month.	Depth in Inches	Year.	Month.	Depth in Inches.
1840	July	1·890	1857	February	1·620
1841	August	2·340	1858	May	1·590
1842	September	2·930	1859	August	1·655
1843	September	3·455	1860	December	1·265
1844	January	1·420	1861	November	3·132
1845	April	1·310	1862	April	1·555
1846	September	1·800	1863	July	1·665
1847	September	2·500	1864	August	1·325
1848	September	1·000	1865	May	2·220
1849	October	3·160	1866	July	2·345
1850	July	2·750	1867	May	1·155
1851	November	2·770	1868	November	2·230
1852	October	1·825	1869	September	2·350
1853	November	1·990	1870	June	2·360
1854	September	1·705	1871	November	2·310
1855	September	2·535			
1856	May	2·135		Average	2·071

Number of Days Rain in each Year, 1840 *to* 1871.

Year.	No. of Days it Rained.	Year.	No. of Days it Rained.
1840	97	1856	99
1841	80	1857	134
1842	89	1858	131
1843	83	1859	127
1844	106	1860	130
1845	97	1861	136
1146	103	1862	118
1847	115	1863	130
1848	98	1864	132
1849	97	1865	111
1850	93	1866	126
1851	100	1867	110
1852	87	1868	103
1853	100	1869	115
1854	114	1870	116
1855	103	1871	110

APPENDIX E.—*Continued.*

TABLE OF RAINFALL FROM THE REPORTS OF THE TORONTO METEOROLOGICAL OBSERVATORY.

Heavy Rainfalls in the Years 1876 *to* 1884.

YEAR.	MONTH.	DAY.	AMOUNT OF RAIN.	TIME IN HOURS.
1876	January	18th	0·620	10
"	February	11th	0·730	12
"	"	14th	0·720	8
"	September	18th	1·250	9
"	October	23rd	0·690	7
"	November	6th	0·710	12
1877	March	26th	1·220	21
"	April	19th	0·800	19
"	July	27th	0·900	2
"	August	28th	0·770	4
"	October	8th	1·010	11
"	November	2nd	0·835	5
"	December	8th	1·360	16
1878	January	10th	0·910	7
"	February	22nd	0·880	9
"	March	13th	0·840	20
"	"	28th	1·130	14
"	May	8th	0·660	3
"	June	23rd	0·675	7
"	July	4th	1·981	4
"	"	26th	1·910	18
"	August	4th	3·450	4
"	"	6th	1·260	1
"	September	1st	1·420	1
"	"	3rd	0·800	15
"	November	22nd	1·150	21
"	December	2nd	0·880	10
1879	June	15th	1·800	14
"	July	10th	0·810	3
"	August	2nd	0·850	1
"	September	14th	1·080	10
"	November	12th	1·090	14
"	December	10th	0·670	11
1880	April	3rd	0·900	14
"	May	7th	1·065	5
"	June	27th	1·240	10
"	July	26th	0·820	3
"	August	27th	0·880	12
"	September	13th	3·085	12
"	"	26th	1·250	8
"	October	5th	0·960	11
"	November	6th	1·010	13
1881	March	19th	1·720	14
"	August	2nd	0·930	15
"	October	12th	0·870	4

APPENDIX E.—*Continued.*

Year.	Month.	Day.	Amount of Rain.	Time in Hours.
1881	November	12th	1·239	13
"	December	13th	0 750	13
1882	January	11th	0 780	11
"	May	22nd	0·840	15
"	June	2nd	1·360	11
"	September	22nd	1·120	9
1883	April	19th	0·920	12
"	May	25th	0·790	9
"	June	18th	1 460	18
"	July	15th	1·370	5
"	August	18th	1·000	7
"	September	24th	0.820	7
"	November	21st	0.725	7
1884	June	24th	0.855	1
"	November	23rd	0.770	8
"	December	6th	1·100	11

Average Depth of Rain per Month.

Month.	Average Depth.	Month.	Average Depth.
1840 to 1871.		1872 to 1883.	
January	1·228	January	1·168
February	0·894	February	0·892
March	1·618	March	1·559
April	2.439	April	2·306
May	3·254	May	3·088
June	2·978	June	2·799
July	3·248	July	3·116
August	3·021	August	2·883
September	3·716	September	3·444
October	2·389	October	2·382
November	2·977	November	2·766
December	1·654	December	1·557

From comparing the monthly means, it appears that the heaviest falls in a single day in September considerably exceed those of any other month ; that the heaviest falls of the year occurred nine times in September (the month of the largest average rain fall in the year), and that the heaviest fall on record in one day (3.455 inches) was in September, 1843.

APPENDIX F.

CITY ENGINEER'S OFFICE,
TORONTO, November 26th, 1884.

Charles Sproatt, Esq., City Engineer:

SIR,—Acting under your instructions, I forward you the results of a few experiments made with floats, taken in connection with the soundings of Lake Ontario, between Kew gardens and a point about two miles east of Victoria Park, made in connection with the main drainage scheme. Surface can floats were used, constructed of pine one inch in diameter, weighted with lead, and about nine feet long, and a shorter description made of one-half inch gas piping about four feet six inches in length; each description had a fan or screen constructed of tin attached to the bottom, and supported by a small flag to enable them to be seen. The only appreciable difference observed in the two descriptions was that the shorter ones travelled at a slightly more rapid rate. You will observe from the attached table that the only days on which the floats moved in a westerly direction was on the 25th and 26th of September, and October 19th. I also give in the attached table the direction and velocity of the wind, taken from the Observatory reports. On the 25th the tendency to float westerly can be placed to the fact that on the 23rd and part of the 24th the wind was blowing steady from the east. The remaining days the floats moved more or less in the direction of the prevailing wind. The Observatory reports for the past forty years shew the prevailing winds to blow from a westerly direction. I would respectfully suggest that as soon as possible in the spring further and more extensive experiments be made in this most important work; as by the Observatory reports, already mentioned, I see that in the spring there are some very heavy storms from east and south-east. So far, from the few results obtained by me, extending only from September 25th to October 19th, the currents noticed have been irregular and accidental, and caused solely by the action of the wind. I attach plan shewing survey of the Lake shore and soundings, and the direction taken by the floats.

Respectfully submitted.

C. H. RUST.

TABLE

Date.	Floats started opposite.
Sept. 23...	.....
" 24...	.....
" 25...	Station 964.
" 25...	" 1514.
" 25...	" 964.
" 26...	" B ....
" 26...	" " ....
Oct. 9...	Victoria Park
" 10...	4983.....
" 11...	Beach Ave...
" 11...	2943·3.....
" 13...	2075.....
" 13...	3460.....
" 14...	2943·3.....
" 15...	2730.....
" 17...	4053·6.....
" 18...	2943·3.....
" 18...	" .....
" 19...	12946·6.....

Several floats we
small boat.

TABLE GIVING RESULT OF FLOAT EXPERIMENTS MADE IN THE FALL OF 1884.

Date.	Floats started opposite.	Distance from shore.	Time.	Direction of Wind.	Direction taken by float.	Time when picked up.	Distance travelled.	Observatory Reports of the direction and velocity of wind.		
								Time.	Velocity.	Direction.
							Mile.		Miles.	
Sept. 23...	.....	.....	.....	.....	.....	.....	...	7 a.m.	9	N.E.
								3 p.m.	6	"
								11 "	1	E.
" 24...	.....	.....	.....	W. by N. W.; shifted to S. W. in afternoon.	.....	.....	...	7 a.m.	6	"
" 25...	Station 964....	.....	12.26 noon.		S. W.	3.12	¾	3 p.m.	22	S.
" 25...	" 1514....	.....	10.36 a.m.		"	12.50	¾	11 "	6	W.
				W. by N. W.; shifted to S. W. in afternoon.				7 a.m.	3	N.W.
" 25...	" 964....	1800′	12.16 p.m.		"	3.23	1	3 p.m.	12	S.W.
								11 "	1	S.
" 26...	" B	700′	12.00 noon.	East; freshened in afternoon.	W.	2.54	1½	7 a.m.	5	N.E.
" 26...	" "	½ mile.	12.12		"	2.45	1½	3 p.m.	14	E.
								11 "	7	"
								7 a.m.	8	N.
Oct. 9...	Victoria Park..	.....	10.40	S. E. in morning; S. W. in afternoon.	N. E.	.....	...	3 p.m.	6	S.
								11 "	5	S.W.
								7 a.m.	7	"
" 10...	4983.....	½ mile.	11.45	S. W.	E. and N.E.	.....	1¼	3 p.m.	17	S.
								11 "	6	S.W.
" 11...	Beach Ave.....	½ "	10.00	"	W. for 500′ then N.E.	.....	½	.....	Av. 10	"
" 11...	2943·3.....	½ "	10.35	"	N. E.	.....	¾	.....	"	"
" 13...	2075.....	400′	.....	N. W. by N.; strong.	E. for a short dist., then S.	.....	¾	7 a.m.	7	N.W.
" 13...	3460.....	1000′	.....					3 p.m.	24	"
								11 "	6	"
								7 a.m.	6	"
" 14...	2943·3.....	250′	10.00	N. W.; strong.	S.	.....	¾	3 p.m.	21	"
								11 "	11	"
								7 a.m.	6	N.
" 15...	2730.....	500′	.....	S. W. by S.	E.	.....	...	3 p.m.	12	S.
								11 "	6	S.W.
								7 a.m.	8	W.
" 17...	4053·6.....	950′	.....	S. W.	E.	.....	½	3 p.m.	7	N.E.
								6 "	6	N.
" 18...	2943·3.....	500′	10.40	N. W.	E.	2.30	...	.....	Av. 10	N.W.
" 18...	"	"	"	"	S. E.	2.35	...	.....	"	
								7 a.m.	12	"
" 19...	12946·6.....	1200′	.....	S. E by E.	N.W.	.....	...	3 p.m.	12	"
								11 "	5	"

Several floats were lost, owing to the heavy sea running at the time, and the impossibility of following them in a small boat.