CITY SANITATION AND SEWAGE DISPOSAL.

By L. J. Clark.

It gives me great pleasure to have the opportunity of again bringing before your attention a subject fraught with so much interest to the people of Toronto, as the safe and economic disposal of its sewage. This is a subject that is engaging the attention and taxing to the utmost the ingenuity of all urban municipalities where the health of the community is held in any regard.

It is also with a good deal of diffidence that I take up a subject we might naturally look for the solution of, at the hands of medical men and civil engineers. Perhaps you will say that it is on the theory that "fools rush in where angels fear to tread," but I would ask you to reserve judgment till you hear what I have to say on the subject, and then render your verdict according to the facts submitted.

City sanitation in its broader sense applies to water supply, house construction, plumbing, street cleaning, meat and milk inspection, etc., as well as sewage disposal, but as those departments are in competent hands, I shall on the present occasion confine myself to the latter subject.

Before entering into the particular scheme I advocate I shall briefly refer to some of the schemes already in the field.

They may be designated: 1st, as Messrs. McAlpine and Tully's; 2nd, Mr. C. Sproat's; 3rd, Messrs. Herring and Gray's; 4th, Porous Carbon System; and 5th, The Iron deodorizing process. The two latter methods may do very well in small towns and inland cities where there is only a choice between these ways and land filtration or sewage farms. But where there is such a cheap and effectual way of getting rid of the trouble, as obtains in Toronto, they are quite uncalled for.

Mr. Emil Knichling has collected some valuable information as to the cost of the various ways of disposing of city sewage. He was employed for one whole year by the civic authorities of Rochester to devise a scheme for meeting the sewage difficulty of the east side of the city, and after a careful comparison of the various methods he makes the following comparative statements :

1. By Chemical Treatment	$595,000
2. By Filtration without cultivation	620,000
3. By Sewage Farming with cultivation.....	860,000
4. By Discharge of crude sewage into Lake	300,000

The above is the estimated cost for the purification of sewage for 63,000 population.

When we consider that Rochester is 6 or 7 miles from the lake we can see how immensely this tells in favor of the City of Toronto discharging its crude sewage into the Lake, situated as it is on the lake shore.

Furthermore, Prof. Laut Carpenter, in his recent report, says : "The value for manure of the sediment obtained by subsidence is 'nil,' and that the deposit obtained by any of the so-called precipitation processes is almost 'nil.' I do not say that they do not in some cases produce a clear effluent, but at considerable cost, and there are *no returns* from the sale of manure."

Another writer says : "That the titles of the companies that have been chartered to convert sewage into manure and failed would fill a good sized volume." And in Messrs. McAlpine and Tully's report they quote authority stating "that *farmers would not haul it away for nothing.*"

The cheap and effectual method I referred to a short time ago is to send it out into the Lake into deep water by the force of gravity, the cheapest and most effectual force in the market.

This brings me back to consider Messrs. Herring and Gray's scheme as well as Mr. Sproat's, as both these schemes require a large *annual outlay for pumping.*

This is the first objection, and not only on account of its expensiveness but also its offensiveness, as the following quotation from the Minutes of Civil Engineering, Vol. 94, referring to the Cheswick Sewage System will show :

"The smell of the sewage is, as a rule, most offensive on Sundays, especially in the evening, when it is often so bad as to make the engine-room *intolerable* even to men accustomed to sewage smells."

Mr. Baldwin Latham says :—"It may be said in the generality of places, if due provision be made for storage, and if the principle of interception be also taken into account, there are few places in this country that need to resort to the expensive process of pumping the sewage in order to secure a free out-fall."

In the face of all this, why, I ask, should a system be adopted that is both expensive and offensive till the most thorough investigation has proved beyond a doubt that *gravity* is unequal to the task?

The second objection I take to the aforesaid scheme (H. and G.'s) is the syphons across the Don. The wells of these, they admit, will have to be cleaned. But they give us no indication how it is to be done, nor have they included in their estimates anything to meet it. This would be no small item if the same precautions be taken to keep these syphons free that are taken with the Boston syphon.

My third objection to the scheme is the location of its outlet pipe, together with the screening station proposed at Balmy Beach and Victoria Park. What an *unmitigated nuisance* would thus be created along that beautiful part of the lake front! All chances of its ever becoming a pleasure resort would be nipped in the bud. It would certainly prove a millstone around its neck.

But last and greatest of all objections is the insecurity of its outlet pipe from becoming choked, or I may rather say the certainty of its becoming choked. It stands to reason that the amount of sewage is dependant on the amount of the city water supply, and as that averages about 12,000,000 gallons per day, we cannot look for a greater amount than that to flow through our outlet pipe ; and, indeed, in the dry season of the year, after deducting what is used for sprinkling lawns and streets, for building purposes, and what is converted into

steam in our many steam-boilers, we shall find that we will have a much less amount than that.

Now, as Messrs. Herring and Gray propose to have an outlet pipe 2,000 feet long and 6 feet in diameter, running out into the lake, the simplest arithmetical calculation will show the velocity with which a given quantity of water will flow through said pipe :—

12,000,000	per	day	will	give	vel. of 9.4	inches per sec.
9,000,000	"	"	"		7.0 "	"
8,000,000	"	"	"		6.25 "	"

This last I consider all we could count on in dry weather for flushing the outlet pipe, viz., $6\frac{1}{4}$ inches per second.

Now it was proved beyond any question by such men as Beardmore, Neville, Latham and Knichling that a velocity of $2\frac{1}{4}$, $2\frac{1}{2}$ and 3 feet per second is necessary to make them self-cleaning. By reference to the table we find that under the most favorable circumstances, viz., 12,000,000 galls. per day, we only get a velocity of about 9 inches per second, or just one-third of what it should be. The inevitable consequence will be that the heavy parts of the sewage that have been carried along in the sewers where the fall has been sufficient will immediately begin to subside when it reaches the submerged part of the pipe, and where the velocity will be as before stated. I venture to predict that if such a scheme were carried out it would not continue in working order one season through.

An instance in point has recently occurred at the Orillia Asylum, where the sewage emptied into the lake through a pipe 200 feet long. Some of the property owners along the water-front complained and 200 feet more was added on. The result was a blockade, and the pipe had to be opened at the former place.

Now let us turn to a brighter prospect. I believe I have a sovereign balm for every evil I have pointed out in the foregoing schemes. It consists in attaching a flushing tank arrangement to an intercepting system somewhat similar to Messrs. McAlpine and Tully's which I shall briefly describe as follows :—

For the sake of analogy we may compare it to a tree-trunk, its roots and branches. Beginning at the top of the trunk we would

start at say the intersection of Gerrard Street and Yonge Street, thence along Gerrard Street East, intercepting Church and Jarvis Street sewers until we meet Parliament Street. Thence down Parliament Street to a little South of King Street, where a flushing tank would be situated. From the flushing tank we would continue South to Front Street, then turn East along Front Street till we meet the Don River. Then sink under the bed of the river to the Eastern side, then follow down the angle made by the bed of the river with its East bank to its new outlet, then turn a little to the East out of the current of the stream and continue out to deep water. Starting from the corner of Parliament and Gerrard, a part of the present Parliament Street sewer may be utilized as far south as Shuter Street. We would there tap the present sewer and take a branch to our flushing tank. The flushing tank and the approach to it would be capable of containing about 500,000 gals. of water and would have an *elevation of 32 feet.* The outlet pipe from the tank out into the Lake would require to be a steel one 6 ft. in diameter, and this would constitute the root of the tree.

The main branch would be an intercepting sewer along Front Street from the Garrison Creek sewer to Parliament Street, where it would connect with our outlet pipe. The second branch would be a similar intercepting sewer on the east side of the Don from about Pape Avenue and running west to join the outlet pipe at the east bank of the Don. Then when the present King Street West sewer is completed from the Subway to Dufferin Street we would have the whole city from west of Dufferin Street to east of Pape Avenue provided for.

The junction of the branches on Front Street East and West would be provided with check valves so hinged that they would offer no resistance to the flow of water towards the outlet, but as soon as the pressure came in the opposite direction they would close and prevent regurgitation in the sewer.

This would then be the working of the system. All the sewage in that part of the city north of Gerrard Street would be brought down the Parliament Street sewer and into the flushing tank, which would be furnished with an automatic flushing arrangement so that when

the sewage in the tank rises to a height of 32 feet it would open the check valve and allow the whole contents to rush out into the Lake. As soon as the tank would be empty the valve would close again and allow it to fill and again empty, etc., etc., "as long as grass grows and water runs," according to the old adage. The time required for the tank to empty would be less than 7 minutes. The time to fill would depend on the supply. If 4,000,000 gallons of sewage were intercepted in 24 hours the tank would be filled eight times or once in 3 hours. If less the time would be longer.

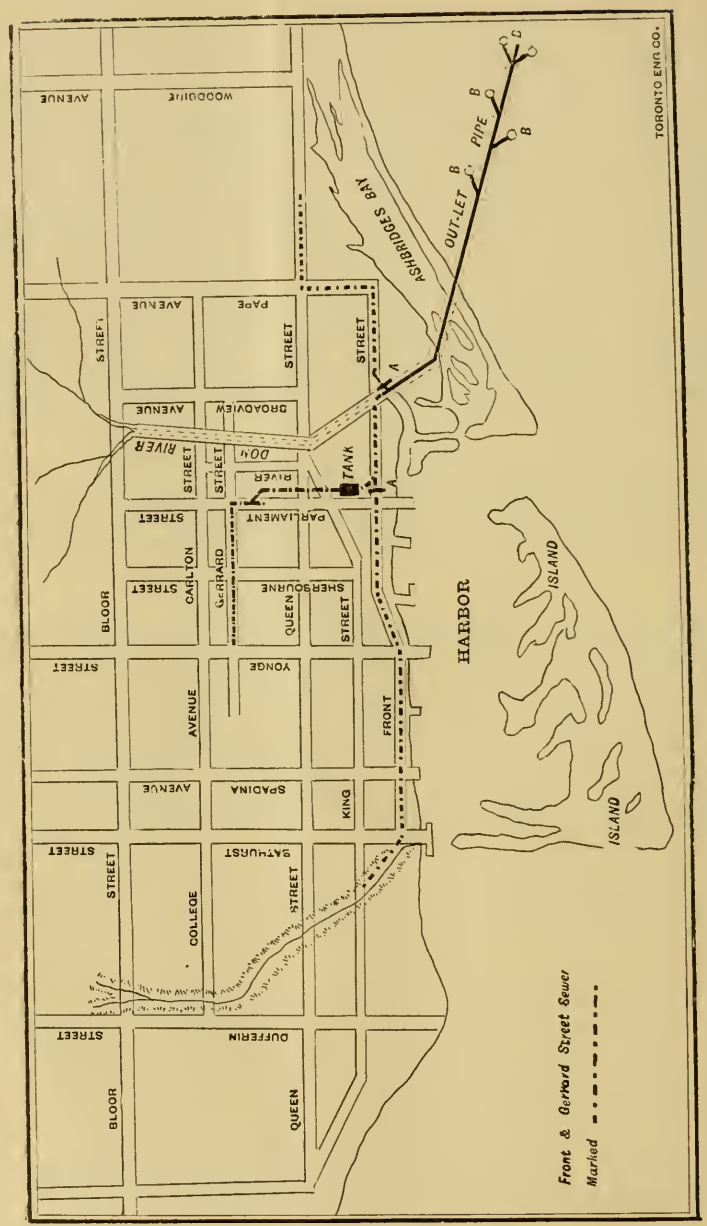
Four flushes per day would be quite sufficient to keep the outlet pipe free, as that is the object of the tank. The velocity of the outlet pipe would be from 6 to 10 feet per second, and would carry along bricks, stones, pieces of iron or lead.

During the interval between the flushings the sewage from Front Street East and West would keep up a constant flow through the outlet pipe, only being checked by the closing of the valves when the tank was in operation.

This short cessation, instead of being a disadvantage to the system, would be a decided advantage to it, as it would produce a slight ebb and flow at each flushing of the tank, which would help to scour it in its lower levels. The fall in Front Street from the bottom of Garrison Creek sewer to the level of the water at Parliament Street, a distance of 11,000 feet is 9.3 feet or 1 foot in 1,183 feet, a very good fall and capable of giving a velocity of $4\frac{1}{2}$ feet per second flowing two-thirds full. Buffalo is projecting a sewer now with a fall of only 1 foot in 4,650 feet. I am afraid they will have trouble there. A reference to the map and drawings will help to make the above description clear.

The map shows probably the best location for the flushing tank. It is provided with a ball and float as shown in Fig. I. This is not an essential part of the system, as a syphon or any other device might be used to open and shut the tank.

Fig. II. shows the bed of the Don with outlet pipe sunk in the angle formed by the bottom with the East bank. The intercepting


TORONTO ENG CO.
ASHBRIDGE'S BAY
OUT-LET
PIPE
B
C
A
TANK
HARBOR
ISLAND
ISLAND
WOODBINE AVENUE
PAPE AVENUE
BROADVIEW AVENUE
DON RIVER
PARLIAMENT STREET
SHERBOURNE STREET
QUEEN STREET
GERRARD STREET
CARLTON STREET
BLOOR STREET
YONGE STREET
FRONT
KING
SPADINA AVENUE
AVENUE
SATHURST STREET
COLLEGE STREET
DUFFERIN STREET
QUEEN
BLOOR
Front & Gerrard Street Sewer
Marked

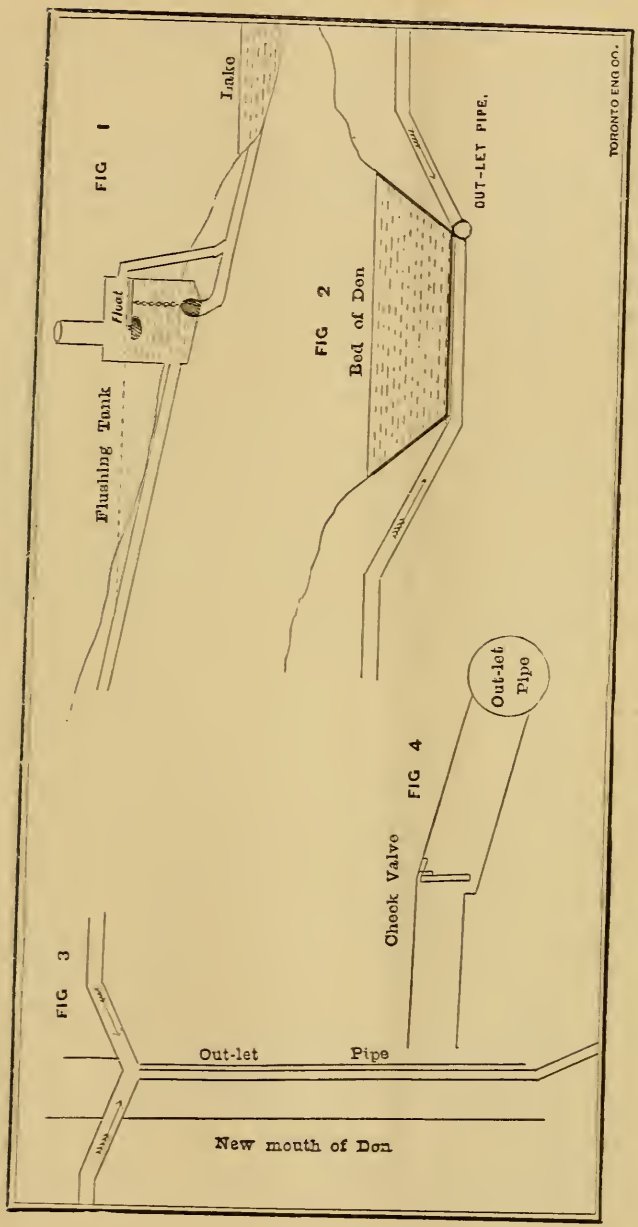


FIG 1
Lake
Float
Flushing Tank
FIG 2
Bed of Don
OUT-LET PIPE.
TORONTO ENG CO.
FIG 4
Out-let Pipe
Check Valve
FIG 3
Out-let Pipe
New mouth of Don

sewers of Front Street—West and East—join here in the outlet pipe.

Fig. III. shows a plan of the same.

Fig. IV. is a check valve to be placed in the branches to prevent regurgitation when the flush is on. It is so constructed that it always remains open and offers no obstruction to the flow of sewage towards the outlet, but when the pressure comes in the opposite direction it closes. Their position is indicated in the map, at letter *a*, *a*. The several outlets indicated on the map by *b*, *b*, *b*, *b* will be referred to later on.

I wish now to call your attention to the capacity of the system and show how it will be able to meet the requirements of the city when it contains 1,000,000 people. A five foot sewer on Front Street West, running $\frac{2}{3}$ full would deliver 32,000,000 gals. per day; allow $\frac{1}{4}$ as much for the East of the Don, 8,000,000. Then supposing the tank fills every 15 minutes, it will deliver 2,000,000 per hour, equal to 48,000,000 per day, making a total of 88,000,000 gals. This is a very liberal allowance, being 88 gal. per head. The Water-works will have to wake up before that time comes.

I come now to the consideration of that part of the subject that has exercised men's minds perhaps more than anything else, namely, the contamination of the city's water supply by allowing the crude sewage to discharge into the Lake. I think that I can show that such a fear is quite groundless. Prof. Laut Carpenter says in his communication with our Mayor and the Board of Health as follows: "With much that has been said both in Chemical and Engineering reports on the self-purification of water, first by discharge into running water of some miles in length and shallow, and second by discharge into a large volume of water containing oxygen I am disposed to agree. I know of many cases in which the first is relied on, for example the Thames (England) receives the sewage of many towns on its banks, such as Reading, Windsor, etc. And yet the water drawn lower down the river for supplying the City of London still passes the test very well. London is considered a healthy city."

During the past summer I visited several American cities for the

purpose of acquiring information on the sewage problem. I found the City of Cleveland more nearly circumstanced like Toronto in that respect than any other place I visited. It has its Cuyahoga River, which is an intensification or aggravated form of our Don. Then they have an artificial harbor much less in size than our bay, into which this river with its discharge from twenty sewers runs, giving a concentrated condition of our own water front. Now, when we consider their intake of water is only one mile from the outlet of their harbor, what need have we to fear when we put five miles between our intake of water and the discharge of sewage? The danger in our case would be just one twenty-fifth of theirs. I was curious to know what an analysis of their water would reveal, so procured a copy of their Water Works report. A very comprehensive series of tests had been made on samples taken at distances of ½ mile, 1 mile, 1½ miles and 2 miles from the shore, a sample was taken 15 miles from the shore at a depth of 75 feet for a standard of comparison, and the following quotation contains the opinion of the "Water Works trustees:"—"It will be a source of general public satisfaction to know that there is no material difference in the water at the present inlet and at other points, and that the supply now furnished is almost equal in purity to that obtained 15 miles from the shore, and that in but few cities in the country are the people so fortunate in having an abundant supply of pure water and at so little cost."

To satisfy myself still further I obtained a report of the Medical Health Officer, Dr. Ashman, which I also found to be very complete. It gave a general death rate of 18.78 per 1000, and of diphtheria and typhoid fever of about 14 in 10,000. These statements indicate that Cleveland is a very healthy city notwithstanding the nearness of its intake of city water to the harbor outlet. I notice that the general death rate for the seven cities of Quebec rises to 31 per 1000 and that the infantile mortality is almost incredible. Through the kindness of Dr. Canniff I obtained statistics which enabled me to deduce the general death-rate of Toronto, which I found to be a little over 19 per 1000, and of diphtheria and typhoid fever to be 13 per 10,000, so that we stand about par with Cleveland. There is not the shadow of a doubt but that there would be perfect immunity from danger in Toronto with the sewage discharge five miles from the city water intake. With regard to the self-purification of impure

water I have a theory which I would recommend to the members of our Biological Section for further investigation. I think it is conceded by all scientists that vegetable life precedes animal life, and also that animal life—fish for instance—cannot live in pure distilled water.

Then it follows that water capable of supporting animal life must contain nitrogenous sub-marine vegetation to be maintained by the nitrogenous production of plants or animals being conveyed into it from the land. It appears to me that if the sewage of the City of Toronto was allowed to flow well out into the Lake and was well distributed, its noxious elements would be disposed of in the following ways. A large amount of it would become oxidized by the free oxygen of the water and another portion would enter into new compounds, promoting vegetable growth, and whatever might be left would be so utterly weakened by dilution as to be entirely harmless. I believe no more harm to our water would arise from a moderate amount of sewage going into the lake than would be done to vegetables and grains, by the application of manure to the soil. The latter is often overdone by our market gardeners, and the result is an unhealthy production of garden "sass." The former is often overdone, as may be witnessed any day at the foot of Yonge Street.

In order to secure a better distribution of the sewage at the outlet, I would recommend that openings be made at three or four different places in the pipe, so that each one might be used a year at a time and then rest for two or three years. I believe that by this method in process of time there would become established in the immediate neighborhood one of the best fish feeding grounds in the lake. It is worth looking into.

The biological analysis of various samples of water made by Prof. Ramsay Wright bears out my contention that no danger to the city water can arise from depositing the sewage in the Lake at a sufficient distance from the intake. He says, "The following are the results obtained on the 8th and 22nd of June respectively. In most cases the number of bacteria given is an average of two and sometimes three samples taken in different bottles."

No. 1. Eastern Gap, June 8th	5000
No. 2. Bell Buoy	0
No. 3. Western Gap	1000
No. 4. Pumping Well	519
No. 5. Reservoir (Rosehill)	10
No. 6. Tap, School of Science	17

A number of other tests was made, but the above is sufficient to show that bacteria do not find their proper environment and necessary pabulum out in the free waters of Lake Ontario.

The analyses that have been made by Dr. Ellis are quite as satisfactory as those of Prof. Wright. I would strongly recommend that these analyses be made periodically and published in the city papers. It would also be well to make a special analysis at the present time of the sewage at the foot of Yonge Street to prove the effectiveness of the Conder system.

I now come to my last consideration and that is, what will it cost to bring about this desirable state of affairs? And here I may say that no city that I have seen or know anything about can be drained so cheaply as Toronto.

While Brockville, Kingston and Ottawa, or Rochester on the other side of the line, have to drift their way through rock and contend with ravines we have nothing of the kind in the city proper, and the slope to the south and east is all that could be desired.

Our largest expenditure would be for the outlet pipe. I have based the cost of this on the price paid to Mr. J. Abell by the city for the water works extension, 12,500 feet of steel pipe, 6 feet in diameter, at $12 per foot would cost $150,000. For laying the same I have made an estimate of $80,000, and as Mr. McNamee, of Montreal, gets $40,00 for laying the water works pipe nearly the same distance, viz., 10,600 feet, with a lot of rock excavation to make, I must surely be on the safe side. For Front Street sewer Messrs. Herring and Gray estimated $57,212 from Garrison Creek to Parliament Street, I allow $120,000 as I require a larger sewer. For making connections with the present sewers, $20,000. These are Messrs. Herring and Gray's figures for all the connections from Garrison Creek to Pape Avenue:—4,000 feet on Gerrard Street, at $10 per

foot, $40,000; 1,500 feet on Parliament Street, $15,000; flushing tank, $20,000; and finally 10 per cent. margin for contingencies, $48,500,—making a total of $533,500.

CONDENSED STATEMENT OF COST.

1. Outlet pipe, 12,500 ft. by 6 ft. dia., $12	$150,000
2. Laying same.....	80,000
3. Front Street sewer, 11,000 ft.....	120,000
4. Connections with present sewers	20,000
5. Gerrard Street sewer, 4,000 ft.	40,000
6. Parliament Street sewer, 1,500 ft.....	15,000
7. Flushing Tank.....	20,000
8. East of the Don.....	40,000
	$485,000
9. Engineer's expenses and contingencies, 10%..	48,500
Total.....	$533,500

I have increased some of these items from my first estimate, on the advice of a friend who has had a large experience in works of this kind.

And now, gentlemen, I have laid before you a scheme which I believe to be entirely unique, and which I believe will pass the most crucial test. Indeed I consider that in laying it before the professional acumen of the society I am submitting it to the most competent tribunal in this city, and if it meets with your approval I shall be satisfied.