

nearest point, only two miles from the Des Plaines River, empties into Lake Michigan at the south end of the lake, and has become naturally the great central sewer of the city; while Lake Michigan, by nature a beautiful clear blue water, is as naturally the source of the Chicago water supply. Thus most of the broad facts of our lesson are before you. The city of Chicago, as you are aware, has had a remarkable history of growth and development. Fifty years ago it was a great marshy tract at the head of the lake, with only a few Indian huts here and there.

In 1870 its population was . . . 298,000 say 300,000
 " 1880 " " . . . 593,000, an increase of 66 per cent.
 " 1890 " " . . . 1,100,000, " " 120 "

With the invariable history of the cities on our inland waters, Chicago began years ago to find as her population increased that the short intake pipes laid into Lake Michigan were supplying other materials besides the pure lake water; and so we have the history of, first, the extension of pipes into the lake, and, second, the construction of a tunnel with the hope of obtaining a water taken beyond the point of pollution of the waters with sewage; but all was in vain.

Then a scheme was thought of, which was to divert the sewage by pumping it over the watershed out of the Chicago river and into the Des Plaines valley. This accomplished some good, but it was found that it only required a heavy rain to fill up the sewers, when the river became filled, much beyond the capacity of the pumps, and the black stream began to pour again into Lake Michigan. Thus it was soon felt that no mere temporary expedients could avail, and the Chicago engineers sought some permanent remedy. This was first in the shape of a great aqueduct out some four miles into the lake, and that the case was urgent is seen in the fact that in 1891 there were recorded some 1,700 deaths from typhoid in a city of 1,000,000 or so inhabitants. This tunnel was completed in 1893, but with six other pumping stations, with local sewers at no great distance from their intakes, only partial improvement was possible.

Along with this tunnel scheme was conceived the idea of constructing a great sewer to the Mississippi, which would flow at all times. This is being rapidly constructed. It is to have an ultimate maximum capacity of 600,000 cubic feet per minute, with a depth of from 22 to 35 feet. Its uniform width in the rock section is 162 feet, and will be 200 feet in the earth portions when completed. There can be no doubt of its being a great and costly work, but as is apparent, it is simply the cutting of a great canal through clay, black loam, and an easily worked limestone. The State of Illinois, by legislation in 1889, provided for the incorporation of the Sanitary District of Chicago, and granted a permit for the work to be carried on, having a beautiful and sublime disregard for anyone but the good people of Chicago, who, getting tired of drinking their own sewage, proposed to supply it to all the dwellers along the Father of Waters down to its mouth.

In return for any incidental inconvenience from this source, they said in effect to said dwellers on the Illinois and Mississippi, "We will supply you with a foot more water to float boats in and improve your commerce"; and to the people living in the other cities and towns, and who go to the sea in ships and do business on the great lake waters, and who are suffering from chronic low water, at the Limestone crossway, in the Detroit river and elsewhere, "Don't be disturbed, if

we rob you of the one-twenty-fifth of the total water which flows down the Detroit river, since, at any rate, the Chicago people will be happy and healthy."

Setting aside, however, all but the sanitary problems attaching to this great work, we can see in them the following immediate effects:

1st. The great sanitary improvement of Chicago, if the lake is freed from sewage pollution and pure water is supplied to the citizens.

2nd. A certainty of the pollution of the Illinois River, already bad, even at Joliette, some thirty miles down, owing to the sewage from the present pumping works.

3rd. An immediate and definite lessening of the volume of water which receives the sewage of the towns along the St. Clair, Detroit and Niagara Rivers.

It is of interest for us to estimate what the pollution of the river at Joliette will mean, and we can understand this by estimating the degree of dilution of the sewage by the waters which will flow through the canal from the lake. As already stated, the estimated flow through the rock section at its maximum capacity will be 600,000 cubic feet per minute, or 864,000,000 per diem. It is calculated that this will be realized with a population of 2,000,000. Assuming this population, and a flow of 100 gallons per head of sewage in the canal, we find that 200,000,000 gallons of sewage per diem equals a flow, including the extra amount from rainfall on the streets, of one hour's flow of the canal. In other words, the dilution of the sewage will be 1 in 24 parts. If we compare this with other cities we find that Pettenkofer states that in the Isar at Munich, the sewage is 25 per cent. of the river flow, and considers this a sufficient dilution to remove all nuisance. Stearns, the engineer of the State Board of Massachusetts, does not consider that 1 in 40, or even 1 in 120, can be accepted as a standard under all circumstances at which rivers may receive sewage pollution. This is in the matter of the creation of a nuisance only, and is not intended to refer to the potability of a river water for a public supply. It is quite apparent, therefore, that the pollution of the Illinois River in its upper portion, at any rate, will be beyond redemption; and, as has already happened, we may expect the question of damages to towns below to crop up at every stage.

As compared with such pollution, that of the St. Clair, the Detroit or the Niagara might be described as accidental; but we already know that the dilution in 18 miles from Buffalo to Niagara Falls, or the diffusion in $\frac{1}{3}$ of a mile between Walkerville and Windsor intake, roughly calculated as 600 times, has not removed the danger from sewage, if it contain the germs of typhoid fever.

The case of Chicago, situated on a lake, in a position similar to Cleveland, Toronto, etc., is an interesting and instructive one, since it supplies us with a sequence of conditions which have in a smaller degree been realized by all the lakeside cities and towns between Chicago and Kingston. The manifest first source of danger is the increase in the population of these cities. The cause of this is a natural one, since in 1890 our great lake system of waters carried 20 per cent. of the tonnage of the water-borne freight of the United States, and, in 1893, 26 $\frac{1}{2}$ million tons passed through the Detroit River. But more than this, we find that over 90 per cent. of the cities of over 10,000 in the United States and Canada, are situated on navigable waters,