RECENT DEVELOPMENTS IN SEWAGE DISPOSAL.

By George W. Fuller, Consulting Engineer.

Mr. President and Gentlemen of the Connecticut Society of Civil Engineers: I am very glad to be here to-day and to say a few words with regard to sewage disposal. The object of this branch of sanitary engineering, as I take it, is to get at the most economical means of removing satisfactorily those wastes which leave dwellings and industrial establishments through the aid of water carriage.

It is an easy matter to speak of obtaining satisfactory sewage disposal, but it is a different proposition to tell practically what should be done and how to do it at the least cost. Theoretically, sewage should be disposed of so that there will be no injury or nuisance either to persons or property. Judgment as to what constitutes injury or nuisance varies with different individuals, State and National authorities, and even to some extent with different courts. In some localities the State statutes cover the general scope of the subject quite comprehensively. In many States the common law alone is the yardstick for measuring injury and nuisance, and its interpretation varies tremendously in different sections.

Natural conditions as actually encountered in practice also vary enormously. Obviously, this must be so, when consideration is given to the wide ranges in stream flow at various places, in its relation to the density of the population in the valleys in question and to the relative volume of sewage flow as compared with the stream flow.

The composition of sewage likewise varies greatly, and frequently has added to it the wastes from street washings and industrial establishments.

The question now is: How are engineers to proceed with the treatment of sewage so as to secure a result commensurate with the cost involved and at the same time allow sewage disposal

practice reasonably to conform to the efforts now under way to provide our cities with pure, safe drinking water supplies, to afford reasonable protection to shellfish obtained from tidal waters, and also to avoid nuisances as to bad odors?

Never was there a time when there was so much general uncertainty as to how best to handle sewage disposal problems. The engineer keenly realizes the tremendous difference between practical accomplishments at moderate cost and the high degree of purification of sewage in expensive works such as is clamored for by the theorist.

Last September I attended a meeting of the International Municipal Congress at Chicago. The representatives were largely doctors and engineers from municipal, state, and provincial governments in the districts adjoining the Great Lakes. One of the principal topics of discussion was that of sewage disposal. Widely varying viewpoints were shown to exist at the very outset of the discussions. The medical men seemed to favor strongly the thorough purification of sewage in all cases. They seemed to think that it is necessary to take that stand in order to promote substantial progress, and that it is wiser to ask for much in order to secure appropriations with which even beginnings in the field of sewage purification might be undertaken.

The engineers present at that Congress, on the other hand, were clearly of the opinion that each problem should be treated on its own merits with the sewage purified to a small or large degree, depending upon the local conditions affecting each problem. The medical viewpoint prevailed, with resolutions adopted by the Congress recording the opinion that no city should be allowed to pour untreated sewage into the Great Lakes in any case where a public water supply would be injured.

In sewage there are four groups of substances which may give trouble if not removed from all sewage as discharged into watercourses, as follows:

1. Floating matters.
2. Settling matters.
3. Non-settling putrescible matters.
4. Objectionable bacteria.

Sewage bacteria are objectionable because they include at times the germs of intestinal diseases and therefore are liable

to promote the transmission of water-borne diseases. Within the past few years the custom has gradually become more and more generally adopted in this country of purifying surface water supplies before delivery to the consumers. It is no longer necessary to resort to filtration for the bacterial purification of water supplies. Sterilization with hypochlorite of lime or other oxidizing chemicals is wonderfully efficient in the destruction of objectionable bacteria, and at almost nominal cost.

Sewage bacteria may also be destroyed by a sterilizing treatment of sewage. If need be sterilization might be practiced on the sewage that enters all bodies of water related either to public water supplies or shellfish layings. So far as drinking water is concerned, sterilization is entitled to most careful consideration, as it seems capable of giving thoroughly adequate protection against disease. Sterilization will not, of course, produce clean water free of mud and vegetable stain nor eliminate objectionable tastes and odors. As a matter of fact, sterilization of water supplies is most generally practiced in conjunction with filtration plants.

While objectionable bacteria have been the source of the chief injury done to surface waters receiving sewage, the need of practicing efficient water purification due to the influence of soil washings from rural districts, independent of the influence of direct sewage pollution, has recently changed materially the engineering viewpoint of sewage disposal.

Engineers are now inclined to regard floating matters, solids which readily settle, and soluble putrescible matters, as elements which need careful attention as to sewage disposal. When they are not eliminated, as happens in a great many cases with American rivers, the latter are made unattractive to the senses. In numerous instances they are overladen with organic filth, particularly near sewer outlets where offensive putrefaction takes place.

Excepting some of the very large rivers, it may be said that there seems to be now on foot a well-defined movement towards securing cleaner rivers. Floating matters should be removed by screening or by the use of settling tanks in which proper baffles are placed to retain those substances which detract from the æsthetic appearance of our watercourses.

Around a great many sewer outlets are accumulations of deposits of the solid matters in sewage and which form what is

frequently called "sewage mud." In altogether too many cases have sewer outlets extended only to the high-water line. Thus they do not provide an opportunity for properly mixing the sewage with a sufficient volume of diluting water.

Where rivers are small, there are instances where the sewage flow in dry seasons causes putrefaction of the entire body of water. Obviously this condition of affairs should not be permitted to continue. The sewage should be clarified and if necessary purified so that the stream is free of putrefactive odors and also contains a sufficient margin of oxygen in the water so as to safeguard major fish life.

For many years it has been assumed by engineers that a dilution of sewage, equivalent to about 3⅓ cubic feet of water per second for the sewage flow of each 1,000 population connected with the sewers, would give sufficient protection against nuisances in our streams. Experience with the Chicago drainage canal indicates that this dilution should be increased, particularly if street washings and trade wastes are a factor, as is true at Chicago. Views are also changing as to the amount of residual oxygen which should properly be left in the flowing water. But little attention was given to this matter in earlier years, but it is now known that at least 20 or 30 per cent. of the atmospheric oxygen necessary for saturating water should be allowed to remain; otherwise fish life may be seriously interfered with. Some observers place the proper margin of residual oxygen at 50 per cent., and still others at 70 per cent. Whatever the ultimate outcome may be, it is certain that the requirements are becoming more stringent than they were a short time ago.

Banks of sewage mud which gradually decompose upon the bottom and sides of watercourses are also consumers of oxygen, and recently it has been recognized that these solid matters which settle quite readily should for a great majority of cases be removed from the sewage before the latter is dispersed in the stream.

Having removed floating matters and those settling solids which subside readily, it is perfectly feasible in my judgment to utilize the dilution method for sewage disposal in numerous instances. Oceans, lakes, and rivers contain a vast amount of atmospheric oxygen which, with various forms of animal and vegetable life, allow certain proportions of soluble sewage mat-

ters to be disposed of without offense. There is no reason why advantage should not be taken of this process of nature, within reasonable limits.

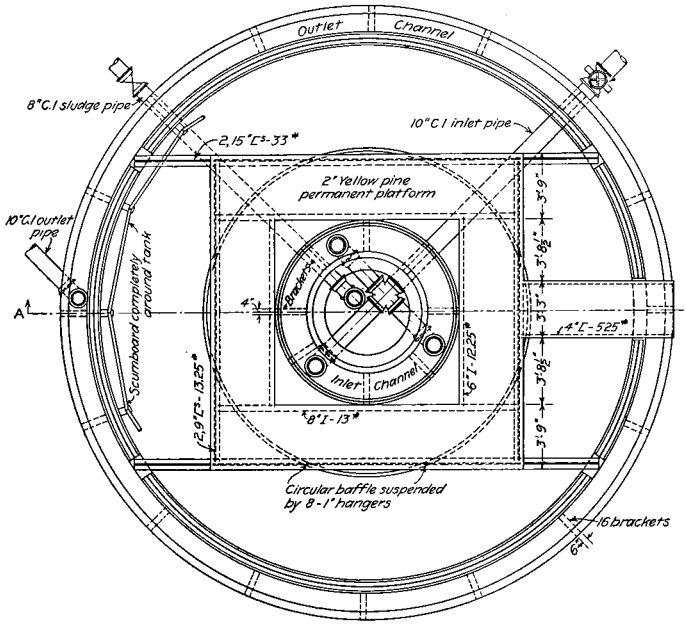
The bacterial protection of water supplies and shellfish layings can ordinarily be taken care of by means of sterilization.

In sizable rivers there are now, as in the case of the Merrimac river, many faulty conditions due to the discharge of sewage with its settling solids on the river bank or so near the river edge that satisfactory results can not be relied upon at all times. In my judgment the time has come when there should be a well-defined movement towards clean rivers. This means the freeing of the sewage of its floating and settling solids and the dispersion of the clarified sewage into the water, so that conditions offensive to the sight and smell do not occur.

It is true, of course, that frequently a stream is so small that it cannot receive the sewage draining into it until the polluting liquid has been thoroughly purified. It does not follow by any means, as suggested by some of the sentimentalists and by some of the medical profession, that sewage purification should be practiced universally to the extent of putting filtered sewage alone into our watercourses.

While I am strongly in favor of cleaner rivers, such as would result from the discharge of screened and settled sewage into our watercourses, and while I am also in favor of sterilizing sewage to protect numerous shellfish layings and some water supplies, I am convinced of the soundness of making use of the oxidizing capacity of our streams within reasonable limits. In other words, the dilution method is still a safe and proper one within certain limits. It is now practiced in many cases in a crude and unsatisfactory way. It is a long step in point of expense from the habit of discharging raw sewage at or near the margin of some convenient watercourse to that of purifying sewage in an efficient way and to produce what some call "spring water."

Between these limits there are intermediate courses making for clean rivers on the one hand and avoiding the expense of complete purification on the other. This is the viewpoint that I especially desire to call to your attention to-day. When we get clean rivers, free of floating solid matters that are offensive to the eye and free of sewage mud with its putrefying deposits, it



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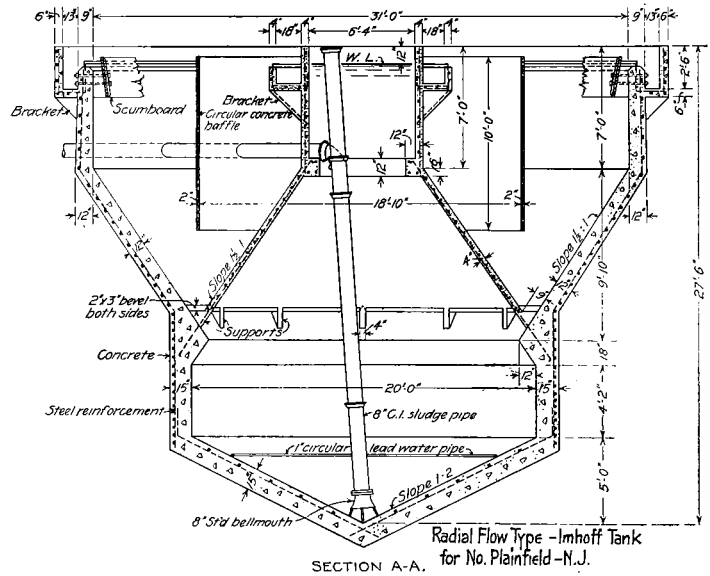
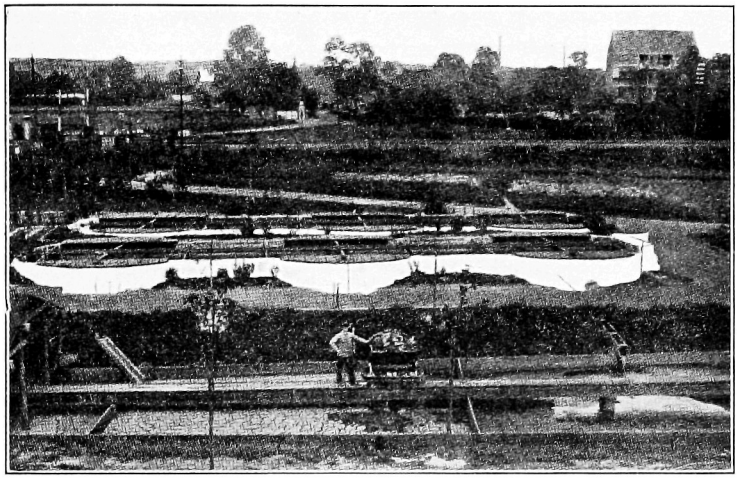


SECTION A-A.

Radial Flow Type - Imhoff Tank for No. Plainfield - N.J.

will be a step in the right direction that may be followed when and as required by more complete purification arrangements, such as filtration.

Fortunately the last few years have seen marked steps in advance in the practical art of sewage treatment. Broad irrigation and chemical precipitation, which were the only methods available twenty-five years ago, have but little standing in this



IMHOFF TANKS, RECKLINGHAUSEN, GERMANY.

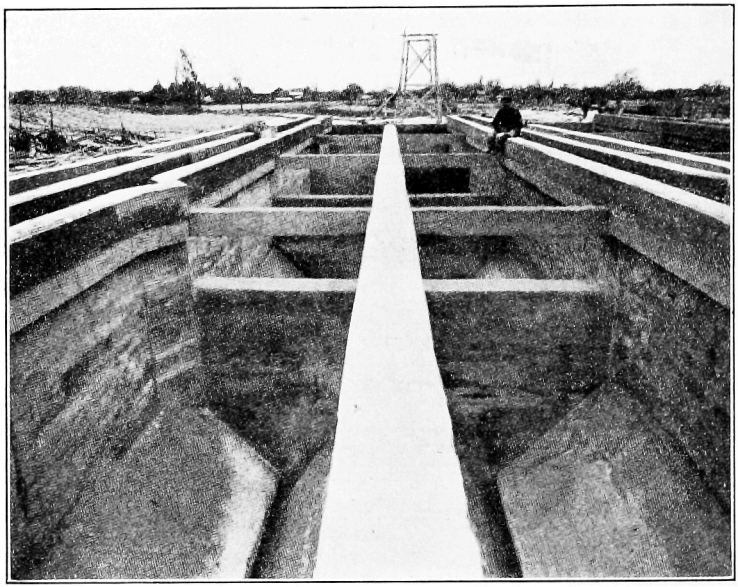
(Courtesy Pacific Flush Tank Co., American Agents for Dr. Imhoff)

The above shows a view of the Imhoff tanks at Recklinghausen, Germany, where this tvpe of tank was first placed in regular operation in February, 1907. The plant serves a population of about 30,000 inhabitants. Since this plant was first installed some 12 plants have been built in the Emscher district, and at least 50 plants either installed or under construction elsewhere in Europe. As will be noted in the picture, this plant is located in the immediate vicinity of some of the finest residences of that portion of Germany.

country now. Intermittent sand filters are found and still well thought of in those localities where porous sandy tracts are available at moderate cost. The sterilization methods already referred to are strong competitors, however, with sand filtration, so far as elimination of disease germs is concerned.

The proposition of securing and maintaining clean rivers free of offensive sewage deposits is promoted efficiently and economic-

ally by means of fine screens or well-designed settling tanks. Fine screens made of wire cloth with thirty or forty meshes per lineal inch are being built for a number of places and have been recommended in still other instances, not only for freeing sewage of course solids in connection with the dilution method, but also as an aid to filters through the reduction in the clogging capacity of the sewage.



IMHOFF TANK, BATAVIA, N. Y. (HORIZONTAL FLOW TYPE)

(Courtesy John H. Gregory)

While sewage sludge has been one of the most difficult matters to treat in the whole field of sewage disposal in works of artificial construction, we now realize that it is this same portion of the sewage which in the dilution method constitutes one of the greatest drawbacks to the dispersion of sewage in large bodies of water. Fortunately, means are now at hand for removing these settling solids in suitably designed settling tanks, particularly of the two-story type, so that the residual sludge may be disposed of cheaply and inoffensively. The two-story septic tank, frequently called the Imhoff tank, is in my opinion one of the greatest steps in advance in the art of sewage disposal that has

taken place during the past five years. In the Emscher District of Germany it has proven an efficient and economical step in the effort toward securing clean rivers. There is great need of some improvements in many of our American streams, especially the smaller ones, and this same method seems to constitute for many cases the best means of solving the problem.

Imhoff tanks are also of distinct aid in the preparation of sewage for filtration, regardless of the kind of material or method of operation. Intermediate sand filters, contact beds, and sprinkling filters are all benefited by having the sewage first clarified by tanks of the Imhoff type.

I shall not speak in detail as to filtration methods, but will proceed to show you a number of lantern slides of devices and arrangements by which sterilization, fine screening, and two-story settling tanks of the Imhoff type may be utilized economically in advancing the well-defined movement which is now asserting itself in this country, namely, the determination to secure clean rivers and generally to treat sewage so as to remove its coarse filth before allowing the liquid portions to become oxidized through dispersion in water.

Before describing the details of these devices shown by the slides, I wish again to point out that these remarks are made with the understanding that water supplies drawn from flowing streams should be well purified before delivery to the consumers, and that it is the duty of the engineer to arrange sewerage systems and disposal devices so as to get clarification as a normal feature in ordinary sewage disposal projects, supplemented in certain instances by filtration or sterilization to meet the demands of some local requirements.

DISCUSSION.

THE PRESIDENT: Mr. Fuller, I believe, stated that he was perfectly willing to be cross-examined. If any one wishes to ask any questions now is their opportunity.

MR. WADSWORTH: I would like to ask Mr. Fuller as to the construction of those sewer beds, how thick they were and how deep was the covering of stone?

MR. FULLER: About six inches of very coarse stone, and then about five inches of coarse stone above that. The sand beds are about two feet thick. That was the plan for the Baltimore beds.

MR. WADSWORTH: All of that was very coarse sand, wasn't it?

MR. FULLER: Yes, I think it could be called coarse sand.

MR. MCKENZIE: Does it flow out over anything except the screenings and is it filtered after it passes through the screenings?

MR. FULLER: It is screened, then it is passed through that tank which holds about a five to eight hour flow, and then it is passed on to the sprinkler.

MR. WADSWORTH: Have you any estimate of the cost of the construction of those beds?

MR. FULLER: I believe the best estimate is that they cost about $40,000 per acre, including the final settling basin, which goes with them.

MR. MCKENZIE: Is that a patented arrangement?

MR. FULLER: I understand so.

MR. MCKENZIE: What is the royalty for the use of those works, or for the use of the patent?

MR. FULLER: It is fifty dollars per thousand of population connected with the sewers. I believe the American representatives have instructions to apply some sliding scale to that, so that it is not quite that amount for the larger cities. I do not know just what it is.

MR. MCKENZIE: That is, they pay fifty dollars down in order to get the use of the right and then it increases as the population increases.

MR. FULLER: It is the population to be served by the tanks when operating at their full capacity.

MR. HILL: You think the Imhoff tank is a decided advance on the old shallow form?

MR. FULLER: Yes, I do, but it is, of course, more expensive to construct per million gallons of capacity. I believe, however, it is not expensive for the work to which it is really adapted. When the case of the sludge system is considered I believe it is not expensive.

MR. MCKENZIE: Can that sludge be pumped out of the bottom or is it too heavy to be pumped?

MR. FULLER: No, it will pump readily under pressure to about five and six feet. If those pipes are laid under about five or six feet it will slide along very nicely.

MR. MCKENZIE: What is the depth of those tanks? I should think from the slide that they were twenty to twenty-five feet.

MR. FULLER: Yes. I think it is a great improvement over the contact bed, so-called, and particularly in this question of clogging, and the ease with which odors which arise from the top of the bed where the sludge is not cared for, may be prevented.

MR. KELLOGG: Then the beds are all filled below the works?

MR. FULLER: Yes, this is removed from the under bed. Of course, there are two of them, so that is the sewage which is last applied to the primary bed. That is the portion of the sewage which is the longest in the secondary bed, and it gets about the same degree of purification as the top flow bed.

MR. MCKENZIE: Would you tell us where the Imhoff tanks are actually in operation, and about the length of time they have been in operation in this country?

MR. FULLER: There are two in service, so far as I know, one at Batavia, N. Y., and the other at Camden, N. J. There are not many connections at either place. At Chatham there is a plant designed to accommodate about seven thousand population. I suppose there are perhaps four hundred connections made there now. There have been no connections made since the winter set in, or since about the first of January. At Batavia I understand there are even fewer connections. The Atlantic City tank goes into service next month.

MR. LEWIS: Did I understand you to say that the tank is self-cleaning?

MR. FULLER: No, it is not. It has about the same degree removable as in the case of a plain sedimentation tank, that is, about one-third of the total organic matter is removed and about two-thirds of the suspended matter.

SECRETARY JACKSON: Mr. Chairman, I would like to move a vote of thanks to Mr. Fuller for his very interesting talk.

Motion seconded.

THE PRESIDENT: You hear the motion. Any remarks. If not, all those in favor say "Aye." Contrary minds, "No." It is passed.