CONGRESS AT GLASGOW.

SECTION II.—ENGINEERING AND ARCHITECTURE.

ADDRESS

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(FELLOW.)

WHEN the Council of The Sanitary Institute invited me to preside over this Section, I felt, whilst appreciating the compliment paid me, that I should experience a difficulty in preparing my address, as the subjects which interest all who are engaged in advancing sanitary work in engineering and architecture cover so wide an area. I decided, therefore, to confine myself to reference to those with which I have had to deal in my own professional life, as they embrace matters of great interest and importance, and, at this time, justify special attention being given to them.

Those who have to advise in regard to works which affect the health of the community have a responsibility which should never be lost sight of. If their functions are faithfully and skilfully discharged, there will result an improvement in the hygienic conditions of our centres of population, with the consequent increase of health and happiness in many homes where, if these functions were not well performed, there would either be loss of life, or of that energy which makes existence useful and enjoyable.

In advising as to the expenditure of public money on sewage outfalls there is abundant data now to determine the right system for each place. I am quite confident from my experience that the conditions vary sufficiently to require intelligent and impartial consideration to be given as to which of the several systems, or combination of them, best meets each case, as it is too often the practice to apply an arrangement of works, or a system, to an outfall because it was applied successfully somewhere else, although the conditions differ materially.

The want of proper provision for dealing with storm water at outfalls is often a fruitful source of trouble. I have had to examine several sewage outfalls where the results were unsatisfactory, and I have found

that failure was mainly attributable to the fact that the discharge at the outfall, through defective construction of sewers or otherwise, of more than three times the normal dry weather flow, which the Local Government Board require to be dealt with as sewage, prevented whatever system of treatment was in operation from having a chance of success. If chemical precipitation was the system, the excessive amount of fluid caused much solid matter to be washed through the tanks which would have been deposited if the flow had been less irregular. If bacterial methods were in operation they were working at a disadvantage, as innumerable colonies of bacteria were being washed away in the beds, their ripeness being thereby destroyed. Waste land of a pervious character, or rough filter beds, if no land is available, should receive discharges due to abnormal rainfall, which should be carefully differentiated from the normal flow of sewage. This admits of fairly close determination, so that an arrangement of works can be designed which will give successful results.

When chemical precipitation was first adopted, the sludge resulting therefrom became a difficulty, as it caused a nuisance. The conversion of the sludge into cakes, by pressing, diminished the difficulty as regards nuisance, and the hope arose that the pressed cake would realize more than the cost of pressing and would prove a source of considerable profit.

Although experience proved this to be fallacious, chemical precipitation is frequently burthened with the cost of sludge-pressing apparatus. Where some land is available this can be avoided by employing chemical treatment to effect the deodorization of the sewage, and to the precipitation of the solids. These may be conveyed in a fluid and fairly inodorous state to the land, to be disposed of and utilized for agricultural purposes without nuisance if dug in promptly. An illustration of this is afforded at the Finchley outfall, where Professor Kenwood has carried out this plan.

In any arrangement of sewage disposal works, a sedimentation tank is now regarded as useful, in order to arrest the suspended inorganic matters in sewage which tend to clog any kind of bed. The great bulk of the inorganic matter is arrested in this tank, provided the rate of flow through it is properly regulated. Some organic matter is also deposited, which is converted into liquid and gas by anaërobic, septic, or cesspit action, the liquid passing away with the sewage. The neglect to adopt this simple preliminary treatment has caused most of the difficulties in regard to the silting up of bacteria beds. By having sedimentation tanks, or other means of arresting inorganic matters, and by using suitable material for the beds, permanent reduction in the capacity of the beds is avoided, or is but trifling.

It has been found that fluctuations in the purity of effluents from bacteria beds will occur when the quality and quantity of the fluid applied varies considerably, which is what might be expected. New bacteria beds require to be treated at the outset with small quantities of fluid, until they have become ripe, that is when the bacterial action has been well set up. By overtaking a bed its efficiency is diminished, whilst by regulating the amount of sewage that is applied to it the best results can be obtained.

Years ago the Massachusetts State Board of Health conducted a long series of experiments for the treatment of sewage bacterially, by passing it through beds filled with gravel stones, which it was stated afforded the best illustration of what takes place in the purification of sewage, and it was found that "the slow movement of the liquid (even with the coarser suspended matters contained in the sewage) in thin films over the surface of the stones, in contact with air, caused 97 per cent. of the organic nitrogenous matter, a large part of which was in solution, as well as 99 per cent. of the bacteria, to be removed during a period of some months."

There is a great amount of information available as to the results obtained at sewage outfalls by various arrangements of bacteria beds and methods of working. In endeavouring to utilize this, one feels that in many cases there has been an adherence to some particular system instead of comparing different systems and arrangement of works under precisely the same conditions as to volume, composition of sewage, etc. The investigations of Mr. Alfred Creer at the York Outfall, of Mr. G. D. Watson at Birmingham, and of Mr. K. F. Campbell at Huddersfield, deserve especial mention as having been carried out without preconceived views or prejudices.

The arrangement and construction of bacteria beds admit of being determined so as to prevent the efficiency and success of the beds from being neutralised, as they often are, by non-compliance with what experience has pointed out as the essentials. If these conditions are complied with, and if the beds are properly worked, a very large portion of the oxidisable and putrescible organic matters in sewage will be removed, and if the effluent is treated in a second series of beds the highest standard of purity is obtainable. I have examined the cause of failure of beds in several places and have found clogging and inefficiency to be often due to the material containing fine particles which settle to the lower part and partially fill up the interstices. In other cases the beds were being worked without regard to the volume or composition of the fluid applied, both of which are factors in regard to the bacterial purification which is aimed at.

Experience has shown that with a given area of land a much larger

volume of foul fluid can be bacterially treated by the trickling or sprinkling system, than by the contact system. In either case the selection of suitable material for the beds is all important, and that which is used must be governed by the locality. The action of aerobic bacteria in the presence of air admits of ready explanation, and that of anaerobic in a cesspit has long been known. I have not yet had a satisfactory explanation of bacterial life in a bed which is alternately filled, emptied, and left empty, for the recognized eight hour cycles.

Twenty years ago I treated crude sewage at an outfall by upward filtration through tanks with false bottoms, over which was a layer of rough stones. The sewage passed slowly upwards through the stones, leaving the larger suspended solids in the false bottom, where they became liquefied by anaerobic action, and the liquid was pumped on to land, with excellent agricultural results. The filter was rested by stopping the flow of sewage at long intervals, when any organic matter that had been retained in the interstices of the stones became liquefied.

In the report to the London County Council by Prof. Clowes and Dr. Houston (issued this year) the results are given of experiments with crude sewage which has first passed through sedimentation tanks at the rate of a unit volume of sewage in six hours. The sewage passed through these tanks to coke filter beds. The following conclusions are given in the Report (page 33):—

“1. That by suitable continuous undisturbed sedimentation the raw sewage is deprived of matter which would choke the coke-beds, and the sludge which settles out is reduced in amount by bacterial action to a very considerable extent. This reduction might undoubtedly be increased by the preliminary removal of road detritus.

“2. That the coke-beds, after they have developed their full purifying power by use, have an average sewage capacity of about 30 per cent. of the whole space which has been filled with coke.

“3. That the sewage capacity of the coke-bed, when the bed is fed with settled sewage, fluctuates slightly, but undergoes no permanent reduction. The bed does not choke, and its purifying power undergoes steady improvement for some time.

“4. That the coke of suitable quality does not disintegrate during use.

“5. That the “bacterial effluent” of settled sewage from the coke-beds does not undergo offensive putrefaction at all, even in summer heat, and can never become offensive. That this effluent satisfactorily supports the respiration of fish.

“6. That the use of chemicals is quite unnecessary under any circumstances when the above method of treatment is adopted.”

The admission of trade wastes to sewers in large quantities causes difficulty to arise in treating the sewage at the outfall, especially when the waste is not admitted at regular intervals coinciding with the varying volumes of sewage, and when undesirable solids are not removed. If the conditions as to the admission of the waste are observed there is no trouble in dealing with it, when it is associated with sewage in reasonable quantities, as the sewage sets up the necessary putrefactive change if the waste is either acid or alkaline, unless in excess, when it should be neutralised before admission to the sewer. In my own practice I have had experience of this, and do not think that there exists any insuperable difficulty in arranging for manufacturers to utilise a sewerage system (when proper safeguards are adopted), as they can fairly claim to do, considering that they contribute to the rates of the town in which their trades are carried on.

In considering the question of pollution, chemical analyses admit at present of a better means of arriving at comparisons than bacterial analyses, as the deductions that can be drawn from the latter are, as yet, a source of controversy.

In determining what standard of purity of effluent should be required, the circumstances of each case will have to be dealt with. Perhaps some minimum standard might be fixed, but there should be no question as to the necessity for carrying out remedial works to prevent crude sewage being discharged into estuaries and rivers to cause nuisance. The nature and extent of the works must be governed by the conditions of the place; as an effluent might be permitted at one outfall which is not chemically or bacterially pure, but where the bulk of the polluting matters having been arrested, the few that remain can be safely left to the purifying influence of the sea, estuary, or river into which it passes.

The requirements of the Public Health Act with reference to the purification of foul fluids before their discharge into rivers, etc., has not been considered as applying to tidal waters, and the Rivers Pollution Act has only very rarely been put in force. Inasmuch as it is illegal under the common law to pollute the air, or the rainfall after it reaches the earth, it is equally illegal to cause a nuisance by polluting the tidal water of an estuary, or the foreshores adjoining, as the Courts have held in cases with which I am familiar.

However skilfully outfall works may be designed and carried out, after all the results depend on efficient management. Some supervision by an official “Inspector of Outfalls” would be an advantage, as it often

happens that an outfall is mismanaged or neglected, with the attendant injury to private interests by nuisance, which involves litigation.

The question of the better conservation of the rainfall of this country is one of national concern, and yet it has not received the attention that it requires on the part of the Government.

Providing water for the communities in a watershed, and removing the fluid refuse from their midst, are so intimately associated that it has often been urged, and properly so, that the country should be divided into drainage areas, forming natural (and not artificial) boundaries coterminous with sanitary districts, so that the needs of the entire population, both urban and rural, within each area should be equitably dealt with. What is imperatively required is an Authority having control over the whole of a watershed area, and responsible to a Department of State. The Royal Commission on Sewage has indicated the desirability of forming River Boards, and the President of the Local Government Board has raised the hope that he will bring before Parliament a Public Health Bill, which would presumably deal with these matters on the lines that have for so long been laid down. I think a Royal Commission would facilitate matters by bringing into definite shape the lines which legislation shall follow.

The past history of our watersheds indicates that they have often been monopolised for the supply of towns whose requirements can only utilise a fractional part of what the watershed is capable of yielding. Many centres of population in rural districts are without any proper water supply, and many are dependent on a well or wells (often far from pure) which fail during periods of draught. I know of many such cases throughout the country, and the requirements of these small communities should not be disregarded as they now are.

We have an object-lesson in the exceptional rainfall of last year. The utilization of the excess water in wet seasons to meet the deficiencies in dry seasons can only be accomplished by the construction of impounding reservoirs in which flood waters would be stored with the double advantages of mitigating the disastrous effects of floods and of better adjusting the balance between supply and demand. In this connection much could be done to utilize the power due to the flow of water from a high to a lower level to which I have devoted much attention, but it is beyond the scope of this address to deal with it.

In considering the question of conserving flood water for town supply, it must be remembered that until quite recently the storage of flood water was objected to, as it was under the ban of being polluted. This leads me to refer to what has removed this ban.

Lord Balfour's Commission on London water had before them a scheme prepared by me for the Water Companies by which at small cost comparatively an impounding reservoir could be constructed in natural valleys of the Thames for the future supply of London. The report of this Commission issued in 1893 was adverse to this, and characterized the storage of flood water as "highly objectionable and undesirable." The report of Lord Llandaff's Commission in 1899 removed the ban, as it stated that "no restriction need be placed on taking flood waters," and also, "it would present a double advantage—the cost of pumping to store would be saved, and it would be possible to take much more water into the reservoir when the river is full as the intake would not be limited by the capacity of the pumps, which cannot deal with more than a fraction of the water passing down at times of flood."

The late Sir Edward Frankland, in a paper at the Royal Institution of Great Britain in 1896, said that "the bacterial improvement of river water by storage for even a few days is beyond all expectations." The better conservation of the rainfall would enable that which is now wasted to be utilized in many parts of the country for irrigation purposes. The present unsatisfactory condition of the landed interests has led to many suggestions with a view to the better cultivation of the land. The establishment of new centres of population by the removal of industries from congested towns to parts of the country where land was going, or had gone, out of cultivation, involved the question of water supply, both for the people thus located and as affording means of cultivating the land surrounding the settlements.

Those who are dependent on underground water for their supply, suffer by the pumping operations of water or mining companies. Although the Courts have held that there is no title to underground water, it must be remembered that this ruling is based on the legal view that water cannot be "identified." In some cases this identification is possible by the employment of lithia, which can be traced, by spectroscopic analysis, considerable distances, as I have had the opportunity of illustrating in a case.

The exceptional rainfall in 1903, and its occurring during the usually hot, dry, and dusty periods, as well as in the usual wet periods, had one good result in preventing the floating dust from being blown about from filthy road surfaces. The effect of this, together with the cleansing of the drains, sewers, and surroundings of houses, was the reduction of the death-rate, that year being one of the healthiest on record, with a death-rate nearly 3 per 1,000 below the average for the previous five years. The adoption of wood-paving and asphalte in our main thoroughfares, although

attended with the advantage of being less noisy (especially as regards asphalt) than the usual macadam road, requires systematic cleansing with hose and water, and good scavenging, especially during warm, dry weather. This is at present very imperfectly done, where it is even attempted, the result being that the air is charged with foul dust from the polluted road surfaces, causing injury to health. The cost of effectively cleansing the main roads of our towns deters local authorities from doing it, but those who regard the matter only as affecting the rates should recognise that the improvement in regard to health, and the increased power of the community to do work, and better work, should be regarded as having a money value.

As bearing upon road sanitation, the present method of preparing the surface of our main roads leaves much to be desired. The employment of asphalt and wood has led to a beneficial reduction in the noise caused by vehicular traffic, but the constant patching of the very uneven surfaces is serious. I am hopeful that in the near future our main roads will be covered in such a way as to be smooth, durable, and as noiseless as any existing arrangement, and I have under observation forms of construction which warrant my entertaining this view. A road thus made would offer a smooth surface for vehicles of all kinds, and when motor traction supercedes to a great extent horse traction, as it no doubt will do, there will result a reduction in wear and tear and noise, together with the all-important diminution of filth and smells.