# THE REMOVAL AND DISPOSAL OF SULLAGE WATER FROM INDIAN CANTONMENTS.

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This is a sanitary question that has deeply concerned the military and Army medical authorities in India for many years, and which has not yet been solved in a satisfactory manner. It may seem a matter of no very great difficulty to the English sanitarian, but in India, where there is no military station at which a water carriage system for sewage has been installed, and where financial and local conditions have to be taken into consideration whenever any method is proposed for the removal and disposal of cantonment sewage, it is one beset with many difficulties. The sullage water referred to in this paper comprises the slops discharged from regimental cookhouses and lavatories, which probably amount daily to about 1,000 gallons per regiment, a not inconsiderable volume to deal with, where there is no sewerage system. This sewage, though a weak one, is liable to putrefy and become offensive, which, together with its bulk, are sufficient reasons for its speedy removal from regimental lines. One of the greatest difficulties connected with the methods tried or suggested for the solution of this vexatious question is, that none of them has been found applicable to all military stations, while some that could deal with bath-house slops are unsuitable for kitchens. It is intended to give a description of the methods adopted or recommended from time to time, with remarks on their applicability and suggestions as to how some of them might be made more satisfactory at certain, if not at all, military cantonments.

(1) *The Catchpit System.*—This was probably the earliest, and for many years—indeed, till not so very long ago—the only method of dealing with sullage water. The slops from cookhouses and lavatories were received into catchpits, which were constructed close outside the buildings. Sometimes these pits were cemented, and the intention was to empty them by hand when necessary, but too often they were allowed to overflow and pollute the surrounding surface; or, through not being completely emptied, the residuum putrefied, caused a nuisance, and attracted flies. Many of the pits were mere holes in the ground—leaching catchpits—from

which the contents soaked gradually into the sub-soil, polluting both it and the foundations of the adjacent wall. Fortunately, this method has been abandoned.

(2) *The Bucket System.*—The large amount of bath-house slops prevents their being dealt with by this method, but it is in general use for the removal of sullage water from kitchens. The slops are discharged into covered iron receptacles holding 5 to 8 gallons, which are kept just outside the cookhouse. One receives the drainings from the sink. None of these receptacles are kept properly covered, and very frequently they are allowed to overflow, through lack of supervision on the part of the native cooks, with the result that the surface under them is constantly being soiled, as cement platforms for receptacles to stand on are not generally provided. Sooner or later a nuisance is caused, and flies are attracted to them in swarms. The contents of these receptacles are emptied daily into the waste-water cart, during which operation soil pollution invariably occurs, for the full vessels are very awkward to empty. The slops are removed in the carts to the trenching ground for burial. It was thought that less nuisance might be caused if the receptacles were kept in the kitchens. Better supervision was ensured, but the number of flies visiting the cookhouse was not much reduced, and it is certainly advisable that neither slop receptacles nor the sink should be in the cooking room. In the new pattern kitchens, the sink will be in a separate scullery. It will probably be some time before this method is abandoned in India, but I think it could be made more satisfactory if the following alterations were introduced: (*a*) The receptacles for sullage water should be replaced by a tank fixed outside the kitchen under the delivery pipe of the sink. (*b*) This tank should be large enough to hold the daily amount of slops of a company cookhouse, about 60 gallons, which result from the cleaning and cooking of vegetables, the washing of utensils and tables and the scrubbing of floors. (*c*) The tank should be placed about 2 ft. from the cookhouse wall, and raised a foot from the ground on small brick piers. (*d*) The sink pipe should enter the tank close to its top, and in the hinged lid should be an opening provided with a screw cover, just large enough to admit the suction pipe of a cesspool pump. A tap in the bottom of the tank would permit of it being flushed and disinfected when necessary. With this method, surface pollution would be obviated, nuisance would be prevented, and flies would not be attracted in such numbers to the kitchen, since the slops could be drawn direct

from the tank into the waste-water cart. If the kitchen floors were properly laid and made impermeable, they could easily be cleaned with a brush and mop instead of being swilled down with an unnecessary amount of water as at present. That the slops have to be finally disposed of by trenching is the great objection to this method of treatment.

(3) *The Surface Drain System.*—This has only been tried experimentally at a few stations, but the engineers report it could be adopted at a good number of military cantonments. The idea is to discharge all the sullage water from cookhouses and lavatories into masonry surface drains, which would conduct it from the vicinity of barracks and discharge it into a "nala" (ditch). The method was found to give very unsatisfactory results with cookhouse slops, since the small amount of fluid discharged at one time through the sink was not of sufficient volume to ensure its being carried far enough along the drains, in which it was found to form small pools, whilst the sides of the drains were covered with a greasy film that became offensive and attracted flies, so that frequent flushing with water was necessary to obviate a nuisance.

Slops from bath-houses, being a weaker sewage and less likely to become offensive, can be more satisfactorily dealt with by this method, and their larger volume ensures a better flow. I do not think the plan would prove satisfactory if the waste water had to be conveyed any distance before it could be discharged into a "nala." However, at many small stations in the hills, where only a short straight run of drain is required to conduct the slops to the hill side, the sullage water from both kitchens and lavatories might be removed in this manner, and in such cases the bath-house drain should communicate with the one from the cookhouse, so as to aid in flushing it, which could be arranged without difficulty, as these two buildings are generally in close proximity to each other. This method would not be practicable where suitable gradiants for drains are not procurable, and would be very expensive if long runs of surface drains were required.

(4) *Irrigation System.*—This method has only been tried experimentally at about twenty stations. In some the results met with were satisfactory, at others it proved a failure, sometimes owing to mismanagement. In this scheme it is proposed to apply the bath-house slops to small gardens laid out in the immediate vicinity of barracks. It is quite unsuited for crude kitchen slops, as the fatty matters in them form a scum on the surface of the

soil, clog its pores, undergo putrefaction and attract flies. Perhaps, if the slops underwent a preliminary purification, by passage through a grease-entangling trap and a downward filter, they might be applied to the land without the risk of causing a nuisance. I do not think this method would ever give satisfaction at large military stations, but I am convinced it would be found suitable for many small stations and also for detached units at large stations. There is no doubt this system has not always been given a fair trial. The gardens have been made too small, too much sewage has been applied, unsuitable ground has been selected, the management has been careless, and then they have been reported as offensive, breeding mosquitoes and giving rise to malarial fevers amongst the troops. To obtain satisfactory results with these irrigation gardens, the following conditions must always be assured:—

(*a*) *Climate.*—Places with a dry climate, such as Nasirabad, Ahmednagar, Multan and Ferozepore, or where the rainfall is moderate, as Jullundur, Agra, Jubbulpore, and Mhow, are all suitable for this method, while at Lucknow, Bareilly, Dinapore, Dum Dum, Belgaum and Rangoon, where the monsoon is often heavy and prolonged, it would probably prove unsatisfactory, at any rate during the rainy season.

(*b*) *Soil.*—Light, porous soils, such as sand, loam, regur (black cotton), and gravelly or sandy loam will be found best adapted for irrigation. On the other hand, stiff clay—unless first prepared—peat, gravel containing layers of hard conglomerate, rocky and water-logged soils, are all unsuitable. The above natural requirements must exist if a trial is to be attempted.

(*c*) *Site.*—The mistake has often been made of placing the gardens quite close to the bath-house. They should be at least 20 feet from the building, but not much more, and, if possible, laid out on a site where the ground has a slight slope.

(*d*) *Area.*—Very often the garden has been made too small, and, as a consequence, has been overcharged with the slops, which formed pools on its surface that made acceptable breeding-places for mosquitoes. The size of garden required must be estimated by the depth of porous soil and the amount of slops to be disposed of. Since a soldier in India probably uses about 1½ gallons of water per diem for ordinary ablution purposes, and 4 or 5 gallons more for his bath, the total daily output of bath-house sullage water would be 550-650 gallons per company. But as every soldier does not indulge in a daily bath, the average number being

three a week, the amount of slops to be dealt with per diem would probably not exceed 400-450 gallons per company, and perhaps less in the cold weather. It has been estimated that a certain area of one of the porous soils above mentioned will take up at a time an amount of water equal to one-tenth of its cubic capacity. Allow that the porous stratum of the land to be treated is only 3 feet in depth, then a plot 24 feet long by 20 feet broad would take up at one charge about 750 gallons of water, far more than is discharged in a day from a company lavatory. So a garden of the above size could deal with all the bath-house sullage water for one day from a company, and also with the kitchen slops if they were first purified in the manner suggested. If the stratum of porous earth was less than 3 feet in depth, a larger area of land would have to be taken up as a garden.

(*e*) *Treatment.*—No matter how favourable the foregoing conditions may be, an irrigation garden will never give satisfaction unless it is also properly made, sensibly managed and carefully attended to in all details. The following is the manner in which a company irrigation garden should be laid out and managed. Having selected a site 25 feet long by 20 feet broad, at a distance of 20-30 feet from the kitchen and bath-house, it should be marked out in two beds, each 12 feet by 20 feet, with a strip of ground 1 foot wide separating them in the middle. A small trench 6 inches deep and the breadth of an ordinary spade should be dug round each garden, leaving the central strip uncut, and similar grips should be dug across the plots at intervals of 2 feet. The earth removed from the trenches should be thrown on the little beds, the surface of which must have been first well loosened between the drains. The gardens should be connected with the bath-house, and, if its slops have been clarified, also with the cookhouse by a well-made ovoid or peg-top shaped masonry surface drain or by drain pipes. This drain should bifurcate a short distance from the garden, one arm opening into the upper trench of each plot. It should be possible to close these branch drains so that the sewage could be applied to the gardens alternately. A better but more expensive method is to dig the garden trenches a foot deep and 6 inches wide, fill them nearly to the top with $\frac{1}{2}$-2 inch pieces of burnt brick or road metal, and on the top of that lay, loosely, lengths of perforated earthenware or corrugated iron gutters. By this means the absorption of the fluid will be assisted. The slops should be applied to each garden alternately to hasten absorption and prevent water-logging, and, if possible, they should be first received into

flushing tanks, which would discharge into the drains at regular intervals. When perforated gutters are not used the bottoms of the little trenches should be carefully raked up every day to prevent a scum forming on the surface, and to help the earth to breathe. Cultivation of these irrigation gardens is not absolutely necessary, but there is no doubt that it will greatly assist the absorption of water. Very often most unsuitable plants are sown. Plantains, canna and lucerne are the favourites. These certainly absorb moisture, but they also afford, during the day, a cool shelter for mosquitoes, which at night may visit the neighbouring barrack rooms, while little pools of water often form in the leaf axils of the plantains and make attractive breeding-places for the Culex. Only grass or clover should be grown during the hot weather and rains, for the transpiration of water by the leaves of these plants is stated to be greater than that of almost any other. During the cold weather lucerne, cabbage and turnips can safely be grown. I certainly think this method could be made to work satisfactorily at a good number of stations, or at least in parts of them, if suitable land was procurable close to the bath-house.

(5) *Bacteriolytic Method.*—So far this has not been adopted at any station in India, but experimental installations gave satisfactory results with both cook-house and bath-house sullage water. It was proposed to discharge the sullage water into drains, open or closed, which would convey it to a septic tank constructed at a short distance from the lavatory and kitchen. The tank effluent is passed through a filter and the filtrate would be discharged into a "nala" or over the surface of land. It has been found that the cook-house slops must be well diluted to obtain a satisfactory filtrate, and for this reason they should be combined with the slops from the bath-house, a matter of no great difficulty since these two buildings are generally close to each other. This method would doubtless yield good results but its installation would be somewhat expensive. To carry it out a small bacteriolytic installation would have to be provided for each single or double company cook-house and bath-house, or a larger one for each corps with which all the regimental cook-houses and bath-houses would be connected. This would necessitate laying a fairly extensive system of drains, which is a very expensive procedure. Again, at many stations proper sewer gradients could not be obtained, and though no fall is required for a septic tank, a certain amount is necessary for a filter, and it might not be obtainable within a reasonable distance of barracks. Suitable land or a convenient "nala" might

also not be available in the vicinity of the lines. Personally, I do not think the cost of such an installation justifiable unless it forms part of a general water carriage system and purification plant for the removal and disposal of all the sewage of the station. Nevertheless, I think it would be an admirable method of dealing with the sullage water and excreta from a station hospital and the drainings from cavalry stables, transport animal lines and slaughter-houses, since the sewage from the last three is, at present, often discharged into an open ditch. One installation would meet the requirements of each of these places, and suitable land is nearly always available in their immediate vicinity for the reception of the filtrate—which could also be safely discharged into a "nala."

(6) *The Water Carriage System.*—This has not yet been introduced to any military cantonment in India, excepting Colaba, which is connected with the Bombay municipal drainage system. Unfortunately, there are many obstacles to the introduction of this system into military stations. For instance, at Rawal Pindi, Mhow, and Jhansi, the want of sufficient water for the working of the system prevents its installation. Again, at Lucknow, Meerut, Umballa, Peshawar, and probably Nowshera, although abundant water is obtainable, the dead level of the surface makes it difficult to procure the necessary gradients for the sewers. While at some smaller stations, where neither of these drawbacks are met with, the cost of the installation would make it almost unjustifiable if only the requirements of a small garrison had to be considered. However, there are large, important and permanent military stations—such as Quetta, where the project has been shelved for the present, Poona, Secunderabad and Bangalore—at which a water carriage system connected with a bacteriolytic purification plant should be introduced, regardless of expense, as soon as possible. Jubbulpore, Agra, and Bareilly might be more gradually dealt with, while Fort William (Calcutta) and Rangoon Cantonment should be connected with their municipal drainage systems. In the case of quarters for regimental and departmental warrant officers and staff sergeants, which are small buildings, officers' messes, and private bungalows, all sullage water could be safely disposed of by discharging it into a catchpit filled from below upwards with layers of stone, coarse and fine gravel, on the top of which is placed a perforated earthenware slab. The kitchen slops should be first strained through a metal vessel filled with straw to entangle the grease which, if not removed, would soon clog the filter.

I think I have mentioned the drawbacks connected with each system that would prevent any one of them being adopted for all military cantonments in India, and have pointed out the defects of those that have been tried, and I think it may be conceded that the removal and disposal of sullage water at Indian stations is, after all, not such an easy matter to settle. Personally, I think it is doubtful if any method will be found applicable for both kinds of slops at all Indian stations. I will conclude my remarks with suggestions as to how the difficulty might be met.

(1) By the gradual introduction of a water carriage sewage system at all large military stations which present no obstacles to the method, and the connecting of cantonments with municipal drainage systems, when such are in existence. The measure would be expensive, but the cost would be compensated by the reduction of enteric, dysentery and malaria amongst the troops.

(2) At small hill stations, and perhaps some others, by discharging both cook-house and bath-house slops, the former, after filtration, into masonry surface channels or drains which would remove them from the vicinity of barracks and dispose of them down the hill-sides or in a ditch. This plan would not be suitable for large stations, where a long line of drains might be required.

(3) By irrigation gardens at small dry stations in the plains, where a suitable porous soil is available, the cook-house slops being first filtered.

(4) For small units—as a battery—and for station hospitals, cavalry stables, transport animal lines and slaughter houses, a small bacteriolytic installation of septic tank and filter beds would meet all requirements. At the station hospital it should also deal with the excreta and urine. If adopted for regiments the expense would be pretty considerable.

(5) By substituting slop tanks for the present cook-house receptacles and emptying them into the waste-water cart by means of a cesspool pump. The great drawback to this method is that the slops would still have to be disposed of in trenches. It is difficult to say what else can be done unless the slops were passed through a septic tank and filter beds, the resulting filtrate being applied to land or run into a "nala." If such an installation was agreed to, it should be large enough to deal with all the cook-house sullage water of the station. Unfortunately, bath-house slops being so voluminous, about 3,000 gallons per diem per regiment, could not be removed in the waste-water carts, which

only hold 60 gallons each, and would still have to be discharged into drains and "nalas," or over land, or conveyed by a series of long masonry channels to a septic tank. Whenever slops or filtrate are run into ditches, particular attention should be paid to prevent them stagnating and forming mosquito pools in the vicinity of barracks. A committee of medical and engineer officers should determine the system most likely to prove satisfactory at the various stations. I have only considered this question of sewage disposal in its connection with military cantonments, but it is just as important a problem for most civil stations in India, where, as a rule, the method in vogue is discharge of the slops into open masonry drains, or ordinary ditches.