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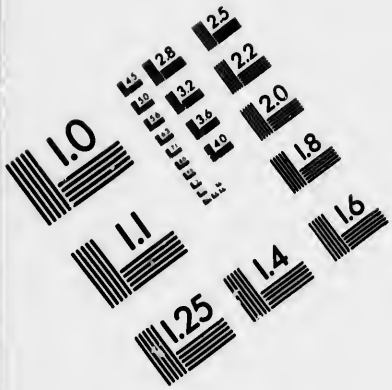

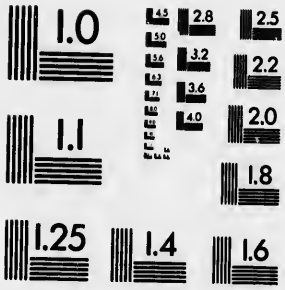

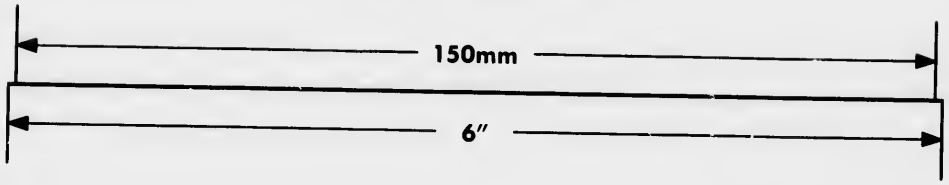

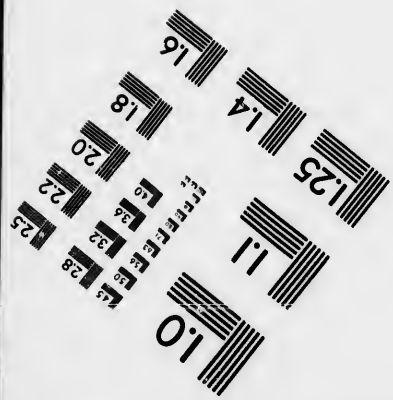

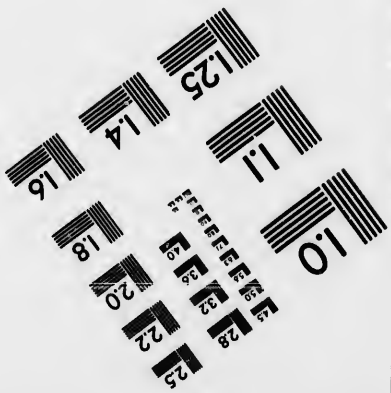

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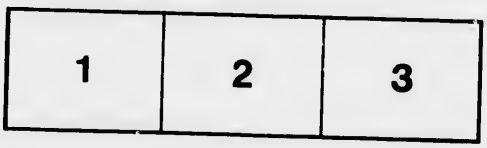

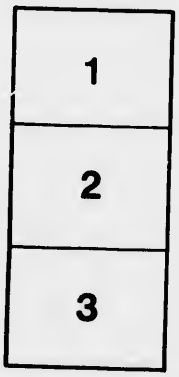

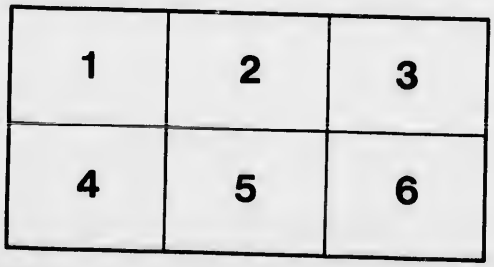

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ON THE DISPOSAL OF SEWAGE.

[No 11.]

ISSUED BY THE PROVINCIAL BOARD OF HEALTH OF ONTARIO.

Toronto:
PRINTED BY C. BLACKETT ROBINSON, 5 JORDAN STREET.
1883.

ON THE DISPOSAL OF SEWAGE.

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Toronto:
PRINTED BY C. BLACKETT ROBINSON, 5 JORDAN STREET.
1883.

The following works have been consulted in the preparation of this pamphlet :—

Report of Massachusetts State Board of Health, 1876.
The Sanitary Drainage of Houses and Towns (Waring).
Parkes's Practical Hygiene.
Wilson's Hand-book of Hygiene.
Bayles on House Drainage and Water Service.
Baldwin Latham's Sanitary Engineering.

ON THE DISPOSAL OF SEWAGE.

In most localities in Canada the supply of drinking-water is taken from wells, and the household slops and excrement are deposited in privies. In many cases the well is in such close proximity to the privy as to give good grounds for the unpleasant suspicion that there may be communication between them. That the well-water has a good appearance and taste and is odourless, is no proof that it has not suffered contamination, since highly-polluted water often has these characteristics; nor is the fact that the privy may be on lower ground than the well a sufficient guarantee of safety, as it may still be many feet above the bottom of the latter. It is a matter of general observation that a deep hole in the ground has a tendency to drain shallower holes in its neighbourhood. In addition to polluting drinking-water, privies poison the air by their filthy emanations, and their ill-effects are aggravated on account of the long intervals that elapse between the times of emptying them. Many instances in various parts of this Province of wells polluted by sewage matter, and of the baneful effects of air rendered injurious in the manner indicated above, have come under the notice of the Board; and it has therefore been thought advisable to issue a pamphlet, pointing out the principles and the best methods to be adopted in order to avoid these results.

In view of the evils mentioned above, the advisability of abolishing the privy-pit system and of substituting something better in its place will not be questioned. The first point to be considered by each municipality is what system is best suited to its own requirements and condition. There can be very little doubt that a properly constructed and connected system of sewers and water-works affords the best means of disposing of the slops and excremental waste; but, in certain cases, the construction of works of this kind may be considered to be out of the question, and some other solution of the problem must be looked for. In many cases conditions very objectionable, from a sanitary point of view, have been introduced, from the fact of the municipal authorities not having considered the system of sewage-disposal best adapted to the circumstances of the municipality, and not having decided upon plans in accordance therewith. Drains and sewers have been built without regard to proper outfall; closets and cess-pools have been connected with drains quite unfitted to receive and safely carry off their contents. Solid refuse, again, has been deposited and left to decompose in very unsuitable places, and, in many instances, houses have subsequently been built on such unhealthy collections of "made soil." It will save a great amount of subsequent expense, confusion and annoyance, if the municipality decide, in the first place, the system best adapted to it and proceed on some settled plan.

This pamphlet will present certain considerations which may be of assistance in arriving at such decision, the services of a competent engineer being at the same time called into requisition in each case.

I.—DRY SYSTEMS OF REMOVAL.

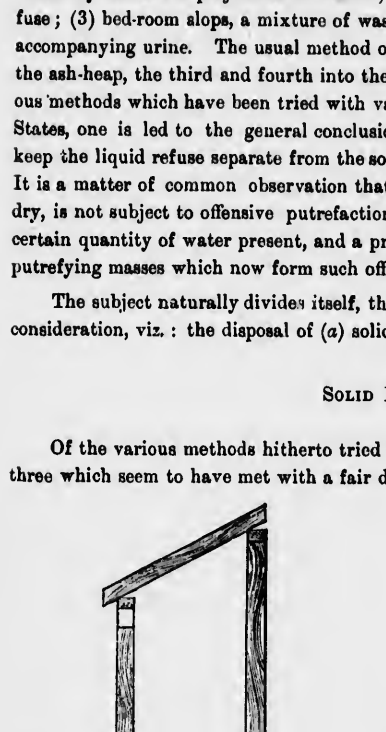
First, then, attention will be directed to the best methods of disposal in those cases where the water-carriage system cannot with advantage be adopted.

In this connection it will be found expedient to consider the question of the disposal of the whole refuse of the household. This consists of (1) ashes, dust, waste-paper, and other dry refuse not prejudicial to health; (2) kitchen-slops and vegetable and animal refuse; (3) bed-room slops, a mixture of wash-water and urine; (4) fæcal matter and the accompanying urine. The usual method of disposal is to throw the first and second into the ash-heap, the third and fourth into the privy. From an examination of the numerous methods which have been tried with varying success both in Europe and the United States, one is led to the general conclusion that the true principle in these cases is to keep the liquid refuse separate from the solid and to dispose of the two in different ways. It is a matter of common observation that solid organic matter, if kept comparatively dry, is not subject to offensive putrefaction, while the reverse is the case when there is a certain quantity of water present, and a practical attention to this fact will obviate those putrefying masses which now form such offensive abominations in our midst.

The subject naturally divides itself, then, into two portions, which require separate consideration, viz.: the disposal of (*a*) solid refuse, and (*b*) liquid refuse.

Solid Refuse.

Of the various methods hitherto tried for the disposal of solid excrement there are three which seem to have met with a fair degree of success. These are—



HULL ASH-CLOSET. (Section.)
Intended to receive all the dry refuse of the household in addition to excrement.

1. *The Hull Ash-closet system.*
2. *The Dry Earth system.*
3. *The Rochdale Pail system.*

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1. The Hull Ash-closet system.

In this closet the back, ends and floor of the receptacle under the seat are built of brick, laid in cement. The front side of the receptacle is a removable wooden piece, and the seat may be hinged. The floor is not sunk below the ground level, but slopes slightly from front to back. The whole is properly roofed in and ventilated. In the receptacle are deposited all the ashes, dust, waste-paper, solid kitchen refuse and excrement of the household. The small amount of urine that accompanies the excrement

is absorbed by the ashes. All kinds of slops are rigidly excluded from the closet. When it is considered desirable to screen coal ashes, they may be screened into the closet after raising the hinged seat.

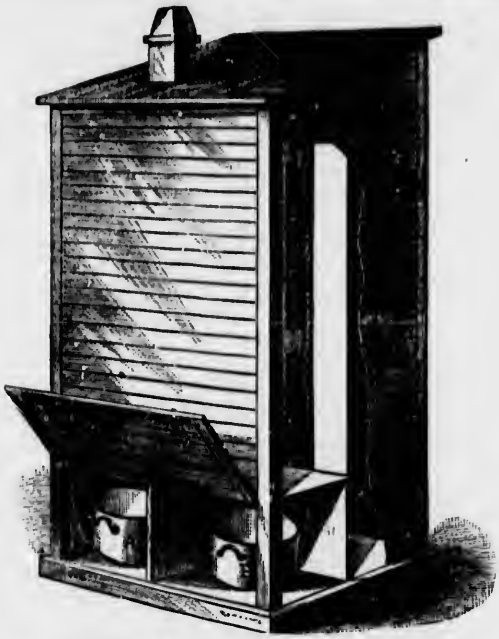
In Manchester a modification of this system exists, the floor being made level and the excrement being received into a pail, mixed with the ashes, as in the Hull closet. In some instances a fixed cinder sifter is arranged at the side of the closet, which directs the ashes on to the excrement and allows the cinders to fall into a box.

Mr. Netten Radcliffe made a careful examination of the Dry Ash system in Manchester, where 6,000 such privies were already in use, and thus reports :—

"In the series of inspections I made with reference to the working of this new system, I had occasion first to observe the contrast as to nuisance between the dry-ash closet and the old midden closet. In several streets where the process of reconstruction had been only partially completed, it was possible to compare the old and new arrangements in contiguous premises. It was the contrast between open, big, uncleanable cavities, containing a greater or less amount of decomposing fæcal matter, and emitting a horrible penetrating odour, and small receptacles, emitting hardly any appreciable smell, even with the nose above the privy seat, and admitting of thorough cleansing. Most significant testimony was given to the benefit of the change by some householders. Many houses in Manchester are built in parallel rows, a back passage running between the rows, and each house having a small yard, in the rear of which the privy is placed. Since the reconstruction of the privies '*it has been possible to open the back windows of the houses.*' The change, moreover, has affected beneficially the value of cottage property, and tenants are quite willing to give 3d. more rent weekly since the reconstruction of the privies for the gain in decency and comfort. Soakage of excremental matter into the soil, and its passage into and accumulation in the drains, is of course obviated by the reconstruction, and the smaller space occupied by the new closet is not an unimportant matter. The removal of the excrement is, with the most ordinary care, free from offensiveness, and if commonly conducted as I saw the operation, it may well be executed during the daytime, and the abomination of night-scavenging done away with.

"The use of cinder-sifters has been adopted by householders with a readiness which proves how accurate the corporation was in depending upon their co-operation in the working of the scheme. The high price of coal during the last two years has contributed to this good result, from the value of the cinders, in encouraging its use. It is found, also, that a class of the population, commonly believed to be unmanageable in regard to any niceties of arrangement for excrement disposal, have rapidly appreciated the advantages of the new closet and taken to the use of the cinder sifter."

The removal is made once a week by the town authorities, and the material stored under waterproof sheds, where it undergoes a gentle fermentation, and is then sold for manure. It is said to be quite as inoffensive in appearance and odour as barn-yard manure.



PRIVY USED IN THE UNITED STATES.

A, Excrement Tub; *B*, Tub of Dry Earth or Ashes; *C*, Hinged portion of Back of Privy.

A modified form of the dry-ash closet has been used successfully in some parts of the United States and Canada. In it two pails are used—one under the seat to receive the excrement and the other in some convenient position for the ashes. Each time the closet is used a quantity of ashes is thrown in with a scoop.

Where pails are used, that for the excrement may be cut out of a petroleum barrel, and should, for ordinary families, contain about ten gallons. In isolated cases a soap box will answer the purpose. The ash-receiver should be larger and may be rectangular in form.

The principal advantage in the use of pails seems to be in the convenience attending the removal of their contents. They are also less liable to be injured, and can be more easily repaired than masonry receptacles.

The above closets are all out of doors.

2. The Dry Earth System.

This system is substantially the same as the dry-ash system above described, with the exception that earth is substituted for ashes. The earths best adapted for the purpose are moulds and loams. Pure sand possesses little or no deodorizing power, while

pure clay is difficult to bring into the proper powdery condition, and has a tendency to absorb too much water.

It is not necessary that the earth should be absolutely dry, the drying that it receives from exposure to the atmosphere being sufficient. For use it must be free from lumps and in a powdery condition. This is best effected by screening it.

After being used it may be placed in a barrel, where it will undergo a slight heating and fermentation, after which it may be thrown out on the floor of the shed and exposed to the air in order to dry, and may then be used again. It is said that this process may be repeated ten or a dozen times with the same earth before it becomes offensive. This, however, is not recommended, especially in a country like ours, unless for the manurial value of the product; but it shows the value of dry earth as an absorbent and deodorizer. Anthracite coal ashes have been found to answer in this respect fully as well as loam. Wood ashes act much more powerfully than coal ashes as a deodorizer. When it is considered no longer desirable to use the material it is sold for manure.

House-closets on the dry earth system have been found to answer the purpose very well. They are usually constructed with some patent device for throwing the earth on the fæces each time the closet is used. One of the principal objects of their inventor, the Rev. Henry Moule, was to find a substitute for the water-closet in dwellings, factories, schools, etc.

With dry earth the soap box or barrel, with a scoop, may be used as in the case of the ash system, and will answer every purpose.

Some excellent automatic earth closets, not very extravagant in price, are, however, made in this Province. The addresses of various manufacturers of them may be obtained on application to the Secretary of this Board.

The principal objections to the earth closet are the large quantity of earth required (estimated at from 4 to 5 lbs. per diem for each person if used only once), and the executive difficulties in applying the system to a large population.

It has proved a success under private management, or where regulations can be enforced, as, for instance, in barracks, factories and various public institutions.

3. The Rochdale Pail System

This system differs from the dry ash-pail method before described principally in the fact that no absorbents are used. The pails are frequently removed, being fitted with tight covers, and clean pails left in their places.

The removal of dry refuse, ashes, etc., forms a part of the system. The excrement and the ashes are brought to a depot, where the latter are spread out on the floor to a certain depth. The excrement is then emptied into trenches formed in the ashes and treated with a small quantity of dilute sulphuric acid; the whole is then thoroughly mixed, becomes, after a few weeks, quite inodorous, and forms a valuable manure. The removal and subsequent treatment has of course to be carried out by the municipal authorities.

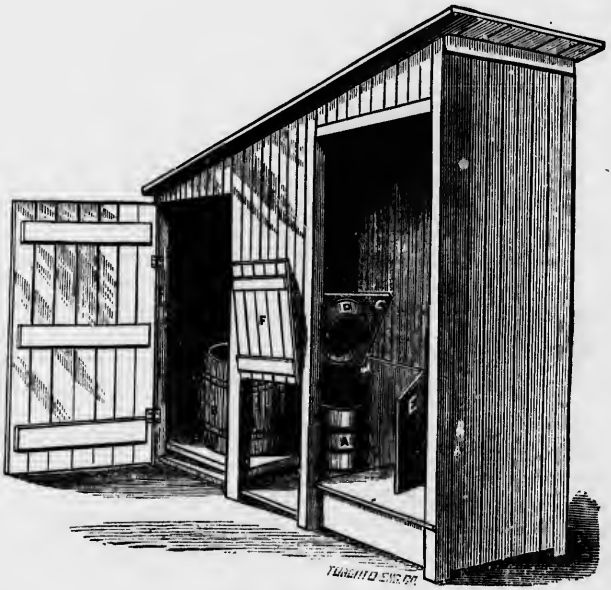
Mr. Radcliffe reports as follows:—

"That the system had been thoroughly approved by all who had had experience of it, and that it had not failed under the most varied circumstances, having proved equally

efficacious in the highly rented house with its own closet, in the lodging-house, where great numbers were accommodated, and in the factory and workshop."

It need hardly be mentioned that this system is suited to out-door closets only.

Under the old privy system in Rochdale the cost of the removal of the excrement of one thousand persons for one year was £71. Under the pail closet system it was £19; the resulting manure selling for three-fourths of the cost of collecting and preparing it.



ROCHDALE PAIL CLOSET.

A, Excrement Pail; *B*, Ash-tub; *C*, Seat Cover (raised); *D*, Iron Collar below seat (reaching into Pail when cover is down); *E*, Hinged Upright of Seat; *F*, Door admitting from outside to excrement Pail.

In this Closet ashes are not mixed with the excrement.

Mr. Radcliffe makes the following estimate of the cost of the dry earth system applied to a village of 1,000 inhabitants:—Original plant, £250; weekly outlay for earth and labour, £4 15*s.*; annual cost, including interest on plant, £260. The product will be 730 tons of manure selling at seven shillings per ton.

In Hull the removal is made by contract. The contractor, in addition to receiving the material he collects and which he sells for such profit as he can obtain, is paid by the sanitary authority from two shillings to three shillings yearly for each house in his district.

Whatever system may be adopted, the old privy-pits should be thoroughly cleaned out and filled with fresh earth.

In many country towns and villages there is sufficient garden space to enable the excretal manure to be utilized ; wherever this is not the case the removal and disposal of the excreta should be undertaken by the municipal authorities, and in all cases they should have an efficient system of inspection carried out.

Liquid Refuse.

In any of the proposed methods of dealing with solid excreta, the kitchen and chamber slops must on no account be mixed therewith.

Wherever practicable a system of pipe sewers should be devised for the purpose of disposing of these and should be connected with the house yards by properly arranged traps. The entrance to these pipes should be under cover, but should not be within the walls of the house. Since the volume of this concentrated sewage will in general be small, the pipes should be smaller and laid with steeper gradients than those used in connection with the water-carriage system. They should also be provided with flushing pipes at intervals, rising to the street surface so as to admit of periodical flushing by means of a hose to be connected with the street watering-cart.. It may be advisable also, for the same purpose, to connect the sewer, at a few points, with the drains and gutters which carry off the rainfall during storms, but great care must be taken to make the connection in such a manner as to prevent the entrance of mud and other street debris. The sewage should not, on any account, be allowed to flow into any open-jointed water-drains, since at particular points in these, and during some seasons of the year, the level of the sub-soil water may sink below the drain, in which case the sewage would soak out into the surrounding soil. Lamp-holes and man-holes, for the proper examination and removal of accidental obstructions, and ventilating-shafts should also be constructed at proper points. Any urinals on the premises should be connected with the sewer and not with the closet. It is almost unnecessary to remark that no sewerage system should be constructed without the superintendence of a competent engineer.

It may be incidentally pointed out here that the trenches in which the tight pipe sewers are laid act as blind drains to a great extent in carrying off the sub-soil water.

The disposal of the liquid sewage when it has reached the outlet of the sewer system presents many difficulties. It may be allowed to flow into large bodies of water, such as our inland lakes, or into large streams, the water of which is not used for drinking purposes, and in which it is so diluted as to be comparatively harmless. There are, however, many objections to the latter method of disposal. If, from the situation of the town or village, neither of these methods is practicable, it may be collected in a large tank, from which it is periodically removed, and used as liquid manure, for which, on account of its concentration, it is peculiarly adapted. This removal may be automatic or otherwise.

Intermittent Downward Filtration.

In some places where it has been found impracticable to use it as manure, the following method has been adopted: A small quantity of waste land is under-drained at a depth of from four to six feet ; the surface is then intersected with open ditches, which are so arranged that when the sewage is poured into them it flows only over a portion of the land at a time. By the action of the air contained in the soil and of the roots of

vegetation, it is purified and then flows through the sub-soil drains into the nearest water-course. The same process is repeated on another portion of the land and then on another, and by the time the whole surface has been treated in this manner, the first portion is ready again to receive the sewage, the soil having had time to dry and re-absorb air. By this method, which is known to sanitarians as "intermittent downward filtration," the soil can never get soaked with water and the organic impurities are thoroughly destroyed by the action of the air and the roots of vegetation.

The requisite extent of filtering area, as estimated by the Rivers Pollution Commissioners (England), is one acre drained to a depth of six feet for every 3,300 of the population, but this ratio must vary according to the nature of the soil.

The soil should be porous and have an easy slope.

Irrigation.

When used as manure the fields are irrigated with the liquid, either by means of surface trenches or open-jointed drain-tile pipes, laid about a foot below the surface. The former method is the cheapest and requires less care to maintain it in good working order. The soil should be under-drained and the sewage should be applied on the intermittent downward-filtration principle explained above.

Sewage farms have been worked for a good many years in England and on the Continent of Europe, and although at first they were looked upon in many instances as public nuisances, yet of late years, with increasing experience and resulting improved methods, they have been gradually growing in public favour. It seems to be the general testimony of medical men, chemists and others, that, when properly managed, they are in no wise injurious to the health of the people in the neighbourhood, and that the produce of such farms, both animal and vegetable, is fully as wholesome as that of any other.

On a sewage farm there should be at least three sets of fields, viz.: one for summer irrigation, a second for winter irrigation, and a third for what may be called storm-water and residual irrigation.

The fields for summer irrigation are treated regularly with the sewage during the growing period of the crop. When the harvesting of the crop or other circumstances render it necessary to stop the irrigation on the fields, it is directed on to the residual irrigation fields. This is also done during storms or floods, in cases where the storm-water passes through the sewers, when the volume of sewage is too great to be used on the ordinary fields. The fields for residual irrigation are best kept in grass and may be used for pasture.

During the winter the sewage is directed on to another set of fields. These are ploughed in the spring and cultivated during the ensuing season without any further addition of sewage: that received during the winter generally proving sufficient.

The experience of Dantzic on the Baltic has shown that winter irrigation is possible even in a cold climate. The mercury is said to fall to 6° or 8° below zero every winter, and in the winter of 1874-5, when it reached 17° below zero, the irrigation was interrupted only three times, and only for a few days each time. "The ground is usually frozen to a depth of three or four feet for about three months; the snow is often several feet deep. The sewage flows out under the snow through the many furrows pre-

pared for it, leaving a thick crust to be ploughed into the land in the spring. About thirty feet from the conduits the sewage often freezes. During the months of extreme cold, though the sand is so porous that the sewage sinks into it readily at all times, filtration alone can be depended upon. Nevertheless, if the plots of land are large and frequently changed, the purification of the sewage is, even in winter, more complete than can be accomplished by any of the chemical processes."

The experience of the State Insane Asylum, Augusta, Maine, has further tested the practicability of this method of sewage disposal in winter. "When the mercury stood at nearly 0° Fahr., and the ground was frozen hard, the sewage was found to disappear very soon after it was put on the land. In the spring the early rains wash any refuse that there may happen to be deep into the soil and no offensive odours are noticed. The surface of the ground is then sometimes found covered with a brownish scum."

In the smaller towns and villages of Canada, where there is usually a sufficient supply of garden space attached to each house in the suburbs and outskirts, similar methods to those described above may be employed on a small scale by householders. Care must be taken to lead the sewage by a tight drain pipe through the ground where there is any danger of its contaminating the drinking-water; it may then be discharged into the garden by a system of open-jointed drain-pipes, placed ten inches or a foot below the surface. If the soil is not very porous it should be under-drained.

In the winter it may be discharged on the surface of the ground if the underground drains are found to choke with ice. Any method of disposal on the surface of well underdrained ground provided it be at a sufficient distance from the house is better than depositing sewage in cess-pits, which experience has shown to be almost invariably in a leaky condition.

The central and more thickly populated portions of the town should be sewered as previously described.

If in any case a cess-pit is considered an absolute necessity it should be built of brick laid in cement with both bottom and top arched. It should be surrounded with a clay puddle and lined inside with a coating of cement. The drain emptying into it should be well trapped, and both drain and pit ventilated at a safe distance overhead. The pit should not be more than six or seven feet deep and should be emptied periodically by the odourless process.

In some public institutions in England where earth closets are used the slops are collected in tanks and sold as manure.

In bringing this subject to a close it may be well to recapitulate some of the facts upon which the above proposed methods of sewage disposal are founded. These are as follows:—Solid organic refuse if kept sufficiently dry does not undergo a putrefactive and offensive decomposition. Coal and wood ashes and most kinds of earths possess great deodorizing properties, and when mixed with solid fæces in the proper proportions will in a short time, through a process of inoffensive fermentation, form a valuable manure. Soils may be repeatedly soaked with liquid sewage provided they are well underdrained and a sufficient time is permitted to elapse between each application so as to allow the soil to fill up again with air, which of course takes the place of the water as the latter filters through. This air oxidises the organic portion of the sewage, and if the under-drains are

deep enough the water flows from them sufficiently purified to be allowed to pass into the neighbouring streams when these are not used for drinking or washing purposes.

The action of the air may be supplemented with advantage by that of the roots of vegetation, and hence it will be found expodient in many cases to establish sewage farms.

No system of sewage disposal has yet been made to pay its own expenses by direct money returns. The most that can be hoped from the use of sewage as manure is to keep down in some degree the necessary expenses of the process. If the ultimate object of all systems of sewage disposal, the health and comfort of the population, is secured at the cost of a not undue outlay there will be good reason for satisfaction.

II.—THE WATER-CARRIAGE SYSTEM.

It is not intended in this pamphlet to deal with all the questions which would need to be considered in connection with a proper system of sewerage. To do so would unduly augment its dimensions, and many such details relate to those parts of the subject which must of necessity presuppose the presence and superintendence of a professional engineer. The pamphlet will therefore take up only those points which may not necessarily or presumably come under the notice of an engineer, and errors in regard to which are constantly causing unsanitary conditions and producing disease.

The primary question of deciding as to whether there are *proper facilities for outfall and a sufficient water supply*, has already been considered in the first portion of the pamphlet. Its importance before commencing or allowing the construction of sewers cannot be too strongly insisted upon.

The materials and joints of drains have also been incidentally alluded to, as also their shape, course, and foundation. In this connection the too common practice of using wooden box-drains must be condemned. They allow sewage to soak out, they soon break down, and they permit of deposit and choking, especially when laid on the flat, as they commonly are. If they are used to avoid expense for any temporary purpose, they should be laid with the angle down, so as to secure a better flow and less deposit. But for a permanent drain, glazed tile pipes, with impervious joints, should be used; or, inside of houses, cast iron pipes, which when hot have been dipped in pitch. The joints of these should be filled with lead and caulked. These inside iron drains should, when possible, be left exposed to view. In some cities this object is carried out by fastening them along the basement walls. Any leakage is in this way made visible, and can at once be remedied. This precaution holds true of all inside plumbing.

The errors which are most frequently coming under notice as detrimental to health are those which allow of the

Entrance of Sewer Gases into Houses.

It is no conclusive proof of the absence of sewer gases that they cannot be perceived by the sense of smell.

Some injurious gases reveal themselves unpleasantly to the nose, whilst others do not. These last are so insidious in their nature as to be doubly dangerous. As examples, the

baneful results which ensue from living in houses under which water lodges and becomes stagnant may be referred to. There are few medical practitioners who have not witnessed these results. The miasmatic poison of ague is similarly inodorous, or has no necessarily unpleasant odour. In like manner sewers have sometimes very little unpleasant smell. In some cases we have a smell somewhat similar to that produced by those burning-fluids into the composition of which fusel-oil enters. People living in a house become so accustomed to these faint odours as to take little notice of them; and with some people the sense of smell is not very acute. Hence we must be very careful how we accept negative evidence as to the presence of noxious gases. And hence, too, we must be all the more careful to avoid their existence and presence, and to devise means to this end.

It is plain that to prevent the constant accumulation of noxious gases, we must in the first place get rid, as far as possible, of decomposable material before it begins to decompose; and, secondly, we must see that the noxious gases from any decomposing material which has evaded our care do not reach us. These two propositions may seem very simple, but in practice we often find that they have not been carried out.

As regards the first of them it has become an acknowledged desideratum amongst sanitarians that all decomposable material entering sewers should pass out of the sewer-system within twenty-four hours. For the accomplishment of this object many points need careful consideration, such as the materials of which drains and sewers are to be constructed, their course, their slope, their bed or foundation, the construction of their joints, the course of their junctions, the facilities for flushing them, etc. Some details in connection with these points have been referred to above; others will necessarily come under the direct superintendence of an engineer.

It will be found that with all possible care in carrying off rapidly the material thrown into the drains, we cannot entirely prevent the collection of a certain amount of noxious gases in them. We find that such gases are in practice disposed of in three principal ways:

1. In a very large number of cases they are allowed to escape into the inside of dwellings. To such an extent is this the case that some sanitarians advise us to abolish sewers altogether, an advice which is not practicable under existing circumstances.

2. In some instances they are supposed to discharge through gratings in the centre of the road bed.

But in many cases they discharge at the edge of the sidewalk through the traps of gullies emptied by evaporation. Examples of this may be seen at many street corners in winter time.

The ventilating gratings of sewers are often so clogged with dirt that they are of little value in disposing of the total amount of sewer-gas. In winter they are very often completely closed.

3. In a few cases the sewer-gas is discharged above the house-tops. Very little consideration will suffice to show that this is the proper method. It is surely safer to discharge it away above our heads than at our very feet.

This method is illustrated in the diagram on page 14.

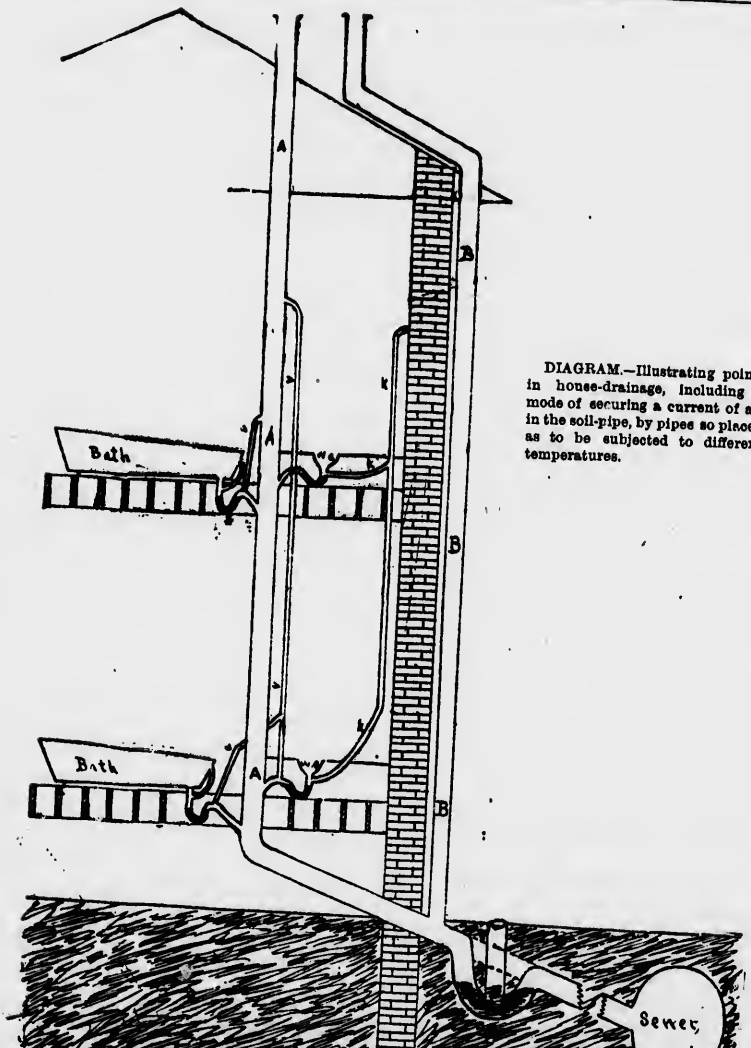


DIAGRAM.—Illustrating points in house-drainage, including a mode of securing a current of air in the soil-pipe, by pipes so placed as to be subjected to different temperatures.

The plate of the above diagram is kindly lent by the State Board of Health of Michigan, it having been cast from a diagram in the report by that Board of an address delivered by Dr. Oldright at a Sanitary Convention at Greenville, Michigan.

It is almost superfluous to say that every precaution should be taken to prevent sewer gas from disposing of itself in the first mode,—by finding its way into houses; and yet a very great deal of carelessness exists on this point.

It will be necessary then to consider how sewer-gases obtain entrance into houses:—

1. In some cases there is no "trap" interposed between the drain or sewer and the interior of the building served by that drain or sewer, no attempt at any mechanical impediment to the return of sewer-gas. This, of course should not be the case. Some form of trap should be placed as near as possible to the commencement of every waste-pipe.

2. Where there are traps they are liable to be forced. Some persons think that if they have a trap all is right, but a trap without a vent is of hardly any practical value. A trap with a protecting depth of water (commonly called the "seal") of three inches, (a three inch seal), only resists a pressure of some two ounces to the square inch. Any person can readily convince himself of the insufficiency of a water trap without a vent by filling such an one and blowing through it. Without any great exertion he can displace the water and force his breath through the trap. If he now make a vent between his mouth and the water he cannot displace the latter no matter how hard he blows.

Let us next consider what influences are at work to force gas back through traps:—

a. The expansive force caused by pouring water into a drain: two bodies cannot occupy the same space at the same time, and if the lower part of the drain be full, or its mouth be closed by water in the sewer into which it empties, then the sudden pouring in of water will cause the confined gas to burst its way back through the trap.

b. Storm-water suddenly filling the sewers has the same action.

c. The expansive force of hot water entering increases the temperature and consequently the bulk of the air. If raised suddenly from 50° to 150° the result would be a pressure equal to nearly seven feet head of water.

d. Direct affliation through the sewer: the wind blowing up the sewers will force the sewer-gas backwards. Some engineers have proposed flap gates at the mouths of sewers. But it is better to let the fresh air blow up, and make sufficient vents for it to sweep through and purify the sewers.

e. Partial choking of the drain gives rise to confined air constantly increasing, expanding and being displaced. A vent allows the escape of all gas which would otherwise force the trap.

3. Again, sewer-gas may be admitted on account of the trap being emptied by syphoning. If to the end of the trap a tube bent downward be added, it forms the long leg of a syphon, the portion of the trap to which it is added being the short leg; if a full stream be poured through the trap, the water will syphon out of it, leaving the seal broken, as may be proved by actual experiment. An opening or vent at the arch of the syphon will of course prevent this.

4. A large body of water rushing full bore down a pipe into which a trapped tube empties will suck the water out of the trap.

This, again, will be prevented by a vent pipe.

5. Alterations may leave some pipe open or unsealed.

6. Disuse of a trap for a long time will allow evaporation and emptying of the trap, giving room for free passage backwards of gas.

7. Corrosion of pipes and traps, or bad workmanship in joints, will often allow escape of gas.

8. By absorption through the contents of traps, gas is often taken up and given off. Dr. Fergus, of Glasgow, experimented with ammonia, and found it transmitted through an ordinary trap in about twenty minutes.

This may be obviated by having a second main ventilating-tube, and these two will form a circulation (as shown in the tubes A and B in the diagram), preventing foul air from accumulating—stagnant—at the trap.

In a system of house-drainage, one of these two tubes may be secured by running a 3 or 4 inch pipe (B) from the sewer, just outside the house wall, up to the roof, clear of cornices, chimneys and windows; whilst the other will be obtained by continuing the soil-pipe (A) up through theroof. A difference of temperature in the pipes will cause the air to circulate through them. The last named pipe (A) will save the traps opening into it from being forced by gas from the sewer and drain. The traps of the baths and lower closet—all traps in fact below the uppermost one—must be saved by their own vents (v, v, v, v,) from being syphoned by sudden liberations of water above. These vents may open into the extended soil-pipe above the highest trap.

In the diagram, pipes (k, k, k,) will also be seen rising from a point below the hopper of the closet, a little above the water in the trap. These pipes may serve a double purpose. By branches from the water-closet tanks they may act as flushers to the water-closet-traps, and they may also ventilate the water-closets. They may lead to the outer air or the chimney-flue of an isolated kitchen in constant use, but never into a bedroom chimney or any other not used *constantly* in the strictest sense of the word. *And never should any tubes which have direct connection with the drain open into the chimney of a dwelling-house.*

As for the trap shown between the house wall and the street sewer it might be left out, were the system to become generally adopted (as it should be by by-law), the drain being then carried directly to the sewer as shown by the dotted lines; for, as remarked before, a point away up thirty feet or so above our heads is surely the best place to discharge the gas from our sewers, and not at our feet. But if the plan were not general then it would not be advisable for the individual to make his ventilating tubes the means for ventilating the whole sewer of his street; though even that would be better, than ventilating the whole sewer by a grating opposite his hall door and sitting-room windows. The best plan even in a general system would be to leave the trap in the position shown and have a third ventilating pipe running up on to the roof from a point just outside of the trap and between it and the sewer. We would thus lessen the danger of even *diluted* sewer-gas finding its way into apartments through corroded pipes or defective plumbing, whilst at the same time overhead ventilation of the sewers would be secured.

In no case should weeping-drains, wastes from refrigerators or other like appliances have direct connection with the drains or drainage pipes of the house.

Dry-traps are not to be relied upon, as they do not entirely prevent reflux of gas.

Great care must be taken to prevent the contamination of drinking-water by the gas or "foul air" of water-closets or drains. For this reason closets should be supplied by pipes from a separate tank, and never from the general system of water supply. Epidemics of Typhoid Fever have arisen from neglect of this caution; and also from contamination by interchange of contents through leaky pipes carrying respectively water and sewage.

Water Closets.

It may be well here to utter a warning against that very common form of closet, the pan-closet, of which a diagram is here shown. The passage from the bowl into the receiver, is closed by the pan, holding water and preventing the constant passage backward of gas when the closet is not in use. But when the handle is drawn up the pan is deflected downwards so as to discharge its contents into the receiver, as shown in the diagram; and, as two bodies cannot occupy the same space at the same time, we have forced up from the receiver the gas rendered doubly foul by the repeated coatings of fæcal matter adhering to its wall as it is dropped on to it from the pan.

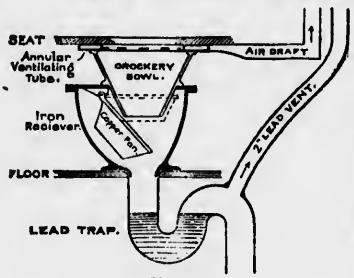


*Fig 2.

There are good forms of patent closets, but the simple hopper with a good swirl of water to keep its walls washed clear of fæces whilst in use, and with an occasional flush, will meet every sanitary requirement and will be free from the objections to which many forms of patent closet are open. The hopper should be of glazed earthenware or porcelain: metal fouls more readily. Its trap should be placed above the floor so as not to leave a long tube between the bottom of the hopper and the surface of the water in the trap. This lessens to a minimum the surface for filth accumulation. The trap is also more accessible in case broken tumblers or other impediments should get into it.

A foul odour often proceeds from the fact of a space being left between the seat and the top of the hopper of water-closets, through which urine or other water may slop over.

Latrines.

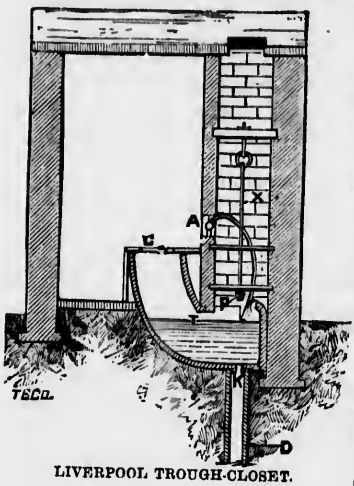
It now seems to be no longer a matter of doubt that the water-carriage system may be employed in this country in connection with out-door closets and latrines. In the densely populated districts in which the water-carriage system is established, these should be made to supersede the privy-pit.

When numbers of persons of various classes have to use closets, they cannot be relied upon for care and cleanliness. Hence it becomes necessary se latrines, which

*This plate has also been lent by the State Board of Health of Michigan.

may be attended to by some servant of the corporation, or other person, who shall, from time to time, change their contents, and supply them with water.

Of the various forms of these latrines, the following may be mentioned :—



LIVERPOOL TROUGH-CLOSET.

1. The Liverpool Trough Closet.—"This may be described as consisting of a series of closets communicating with a long trough [T], situated beneath and behind the seat [C], which receives the excreta from each closet in the series. The lower end of the trough communicates with a drain [D], leading to the sewer by an opening [K] which is closed by a plug [P]. Behind the back wall of the closet there is a small space [X] to which no one has access but the scavenger, and from which alone the plug can be raised by means of a handle. The scavenger visits daily, empties the trough, washes it out with a hose connected with a hydrant [A], and again charges it with water. As much water is let in as will cover the excreta received during twenty-four hours, and so prevent any smell. The closets are kept clean by the users."

2. The Bristol Eject.—"This consists of a strongly constructed dip-trap, interposed between the privy-trunk, as the receptacle is termed, and the drain. It thus admits of the ready extraction of foreign matters which may be thrown in ; it is not easily broken ; and, as it is flushed and kept clean by the servants of the corporation, it is found to answer much better than ordinary water-closets among the poorer classes of large towns."

3. Other forms of Latrines, on the same principle, are thus spoken of in Wilson's "Hand-book of Hygiene :"—

"For barracks, prisons, etc., water-latrines of a much simpler construction than either of the above answer exceedingly well. An open metal trough, roofed in, and with the necessary partitions and doors, receives the excreta, while its anterior upper margin constitutes the seat. In order that the excreta may be constantly covered, the trough should be kept one-third full of water. It should also be well flushed at least twice daily, and the contents allowed to run off into a drain connected with a sewer. A plug, or flap-door, at the lower end of the trough will be required to prevent the water from draining off during the intervals.

"There is a futher advantage, common to all closets of the trough system, which may here be pointed out. In the event of an epidemic of cholera or enteric fever raging in the crowded courts where these closets are in use, it will be an easy matter to throw disinfectants into the troughs, and thus destroy the infectious power of the alvine discharges."

In some latrines water does not stand in the receptacle, but is admitted daily to sweep out the contents with a sudden flush. Those in which the fæces are received into

the water, the whole being suddenly let off and flushed, are to be preferred, where the receptacle can be placed at a depth sufficient to protect it from frost, as is done now with our water-pipes, hydrant-services and drains, always remembering, however, that the open troughs are more exposed to atmospheric changes of temperature. In this Province out-door water-closets have, in some instances, been introduced, and, when carefully constructed, have been found to work satisfactorily in the winter season. Great care, however, needs to be exercised.

4. In various cities on the Continent, so-called "*Iron Sinks*" are manufactured, and are being largely introduced.

In New York the change from the old system to the new is being gradually made. No new pits are allowed to be dug; and when any existing one becomes a cause of complaint, the following order is issued by the Board of Health and must be carried out:—

"That the privy vault thereat be emptied, cleaned and disinfected and filled with fresh earth. That a receptacle, vault or sink be constructed thereat, of a depth not greater than two feet, which shall be impermeable and secured against any saturation of the walls or ground, and shall be connected at the upper end with the Croton water, and at the lower end with the street sewer, and provided with an outlet at the lowest point and on the bottom so as to admit of the complete discharge of the contents and of being daily flushed with water. The bottom thereof shall be so inclined that the lowest point at the outlet shall be at least six inches below the lowest point at the opposite end."

In these privy sinks the hopper and trough are all in one piece. They are similar in principle of construction to the trough-closets above noticed. They are very moderate in price, one with two holes costing about $15.00; with three holes, $20.00, and so in proportion.

Some places, such as factories on the course of our largest rivers, may be so favourably situated as to allow of troughs with a continuous stream; but extreme vigilance, as regards outfall, must be exercised in connection with this practice. Numerous cases of drinking water polluted by excrementitious sewage have come under the notice of this and other Boards.

Urinals.

Urinals become offensive through want of proper provision for preventing the incrustation of them with deposits from the urine, and of proper means of frequently cleansing or removing surfaces which collect the droppings. A tray of ashes or saw dust in front of, and beneath, the urinal will meet this latter requirement, the contents of the tray being frequently changed. For the first mentioned cause of offensiveness, it seems necessary to have a flow of water washing the urinal, whilst in use. Disinfectant contrivances should also be used.

Intercepting Tanks.

In many places where the natural facilities for outfall are not very good, the mixed contents of sewers are received into tanks, the solid portions allowed to settle, the liquid portion removed and disposed of in the methods described in connection with liquid refuse in the first part of this pamphlet, and the solid settlings also removed, mixed with earth, ashes or chemicals, and used for manure.