Handbook of rural sanitary science illustrating the best means of securing health and of preventing disease / by C. F. Gardner, C. N. Cresswell, William Berry, Thomas Hennell. Edited by Lory Marsh.

HANDBOOK OF RURAL SANITARY SCIENCE

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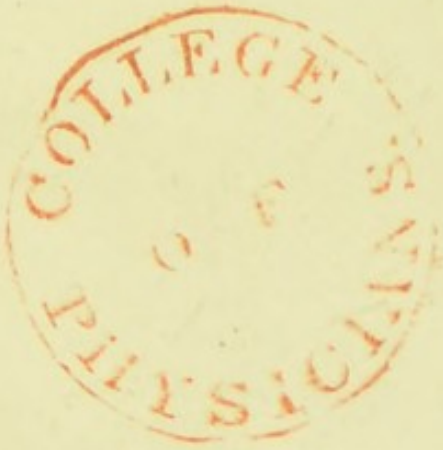
RURAL SANITARY SCIENCE



HANDBOOK

OF

RURAL SANITARY SCIENCE

ILLUSTRATING THE BEST MEANS OF SECURING HEALTH AND OF PREVENTING DISEASE

BY

C. F. GARDNER

WILLIAM BERRY
L.R.C.P.EDIN., M.R.C.S.ENG.

C. N. CRESSWELL
BARRISTER-AT-LAW

THOMAS HENNELL
ASSOC. INST. C.E.

EDITED BY

LORY MARSH, M.D.
MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS, LONDON
MEMBER OF THE ROYAL COLLEGE OF SURGEONS, ENGLAND
ETC.

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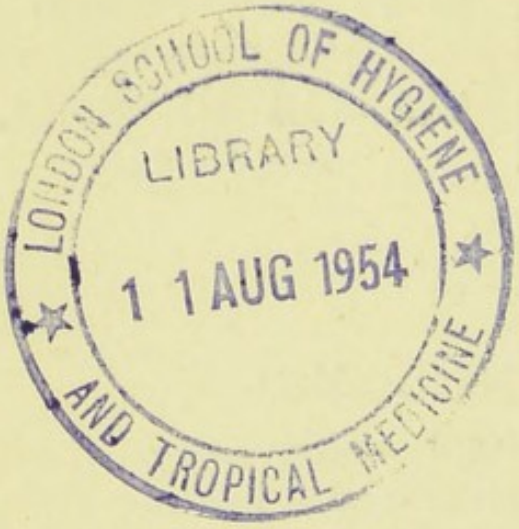

PREFACE.

The great amount of preventable sickness and premature death resulting from neglect of the laws of health, together with the importance of a better appreciation of sanitary matters, especially in rural districts, is now pretty generally admitted. It is hoped that the present volume will in some measure supply a want long felt of a handbook on Rural Sanitary Science, containing an epitome of what has been done to improve the sanitary condition of the country, as well as what still requires to be done in the same direction.

Early in 1875 I offered a small prize for an essay upon 'Rural Sanitary Science and its further application, with a view to ensure the highest condition of health and to prevent disease.' Mr. Bailey Denton, C.E., and Mr. James Howard, of Bedford, kindly undertook the responsibility of adjudicating upon the

essays, and I desire to take the present opportunity of thanking them for the very valuable assistance they have rendered me in the matter, as well as for the great care and attention they gave to the subject.

The essayists were directed to address themselves:—To the powers possessed, but not exercised, by the Local Government Board, and to the effect of diversity of opinion existing amongst its advisers. Also as to any new powers they would suggest as desirable to invest the Board with. Further, as to the applicability of the standards of pollution of effluent waters recommended by the Rivers Pollution Commissioners, and the subject of the non-pollution of rivers.

In judging of the merits of the essays the following points were to be taken into consideration:—

1.—The practicability and facility of applying the treatment proposed by the authors for securing:—

(*a*) Supply of pure water;

(*b*) The discharge of refuse;

(*c*) The disposal of refuse.

2.—The nature and simplicity of Rural Sanitary Organisation whereby to secure:—

(*a*) Purity of air within and around dwellings;

(*b*) Cleanliness within and around dwellings;

(*c*) The best means of carrying out the above objects under the most varying circumstances.

Nineteen essays were sent in, and the prize was awarded to Mr. C. F. Gardner, of Ashbourne, Derbyshire, whose essay is comprised in the first five chapters of this work, and bore the following motto:—

'ὥσπερ ἱματίων ῥαγέντων εἰσί τινες ἡπηταί, οὕτω καὶ οἱ ἰατροί, ὅταν τινὲς νοσήσωσι, τότε ἰῶνται τούτους· σοὶ δὲ τούτου μεγαλοπρεπεστέρα ἔσται ἡ τῆς ὑγιείας ἐπιμέλεια.'—XENOPHON, *Cyropædia*, i. 6.

'As there are persons who mend torn garments, so there are physicians to heal the sick; but your duty is far nobler, and one befitting a great man—viz., to keep the people in health.'—*Translation.*

Mr. Gardner will be known to many as the author of a successful essay on 'The Inequalities and Anomalies of the Present System of Local Taxation.'

In making their award, the adjudicators specially recommended as deserving 'honourable mention' the essays by Dr. W. Berry, Mr. C. N. Cresswell, Mr. T. Hennell, also those by Mr. W. H. Tyson, of Hulme, and Dr. Ward, of Grange-over-Sands.

The prize essay is printed in full. The remaining essays were placed in my hands to arrange for publication; and in carrying out this very agreeable task I have endeavoured to put before the reader the

original views of each writer, whilst I have striven to avoid as much as possible a repetition of those matters which have been treated of in other portions of the book.

As the independent expression of several writers, it is hoped that the present handbook will be found to contain many useful suggestions upon the subject of urban as well as rural sanitary science, and that it will prove a useful pocket companion for justices of the peace, clergy, sanitary officers, members of local boards, as well as of the public generally, who are anxiously looking for the realisation of that important declaration, 'the first care of a Minister is the health of the people.'

LORY MARSH.

11 Spring Gardens.
Charing Cross, S.W.

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RURAL SANITARY SCIENCE.

CHAPTER I.

INTRODUCTORY REMARKS—PRESENT ASPECT OF SANITARY MATTERS IN RURAL DISTRICTS—PREVENTABLE DISEASES.

We learn from the Court Rolls of Stratford-on-Avon that Shakspeare's father was fined in the year 1552 for depositing filth in the public street, in violation of the bye-laws of the Manor; and again in 1558 for not keeping his gutter clean,—a proof that in the time of the Tudors nuisances were not tolerated. The statesmen of that period appear to have turned their attention very carefully to many matters of social economy. A sanitary law had indeed been passed as early as the year 1388, to prevent the pollution of rivers; but an appeal to the Common Law of the country afforded the only means by which people could, generally speaking, claim protection from injury to health and comfort. This being an expensive process, they, as a rule, submitted to the nuisance. It is not our intention to enter at any length upon the history of Sanitary legislation in this country. It will suffice to notice, that after

the reign of Queen Elizabeth the means of securing the public health gradually became neglected; and with the exception of special Acts, directed from time to time to meet the attacks of plagues and pestilences, no general measure, applicable to the whole kingdom, was passed until the ravages of Asiatic cholera in 1831 led to a move in Sanitary reform. Since that date numerous Royal Commissions and Parliamentary Committees have reported on almost every conceivable aspect of the question, and legislative measures have followed each other in quick succession, until at length the laws of public health have become so complicated and confused, that those whose duty it is to carry out their provisions are fairly bewildered. During the session of 1875 an Act of Parliament was passed chiefly for the purpose of consolidating these laws. It will therefore be needless for us to occupy a limited space by alluding to the Acts which it is intended to replace. At a future page,[1] we shall have occasion to discuss this Act more particularly.

Sanitary legislation, in order to be effective, should provide for the supply of wholesome water, sewerage, drainage, removal of refuse, control of streets and buildings, the prevention of over-crowding and sale of unwholesome food, as well as other means of promoting the public health. It should also guard against the introduction and spreading of contagious and infectious diseases and epidemics

[1] See p. 93.

affecting the health of man.[1] If measures with such objects be well carried out, the people will enjoy comfortable dwellings, pure air as far as Nature will permit, and a sufficient supply of good water and wholesome food.

But before proceeding to describe what appear to us the best and simplest means of securing these advantages in the highest degree in rural districts, it may be well to look around us, and see what is the actual state in which the rural population of England are living in the present day. Abundant means for obtaining information are to be found; but Parliamentary Blue-books, and papers read at the meetings of Social and Scientific Societies, are not within the easy reach of all. Moreover, little general interest is taken in such matters, and great and even culpable ignorance prevails extensively.

The Reports of the Royal Commission, appointed in 1867 to inquire into the employment of children, young persons, and women in agriculture, reveal some painful facts about the dwellings of the peasantry. Lord Napier and Ettrick, in his opening address at the congress of the Social Science Association held at Plymouth in 1872, says that 'nothing is disclosed in stronger colours in these reports than this, that the dwellings of the rural population urgently demand a very general reconstruction. It would be hazardous to assert in the face of those statements that more than two-thirds of the existing habitations are satis-

[1] Second Report of the Sanitary Commission, vol. i. p. 15.

factory or susceptible of improvement and enlargement.'[1] The Hon. Edward Stanhope, one of the Assistant-Commissioners, reports that in 42 villages which he visited, 314, or 62 per cent., of the cottages had but one bedroom; whilst in one village there were 59 cottages with the same want of accommodation; and that in all the counties which came under his inspection the condition of the cottages was 'bad.' The same opinion is expressed more or less strongly by other Commissioners, as to the miserable condition of the cottages of the peasantry generally. But the strongest report of all is that by the Rev. James Fraser, an Assistant-Commissioner, now Bishop of Manchester. His description is so graphic that we will give one or two extracts; he says:—'The majority of cottages that exist in rural parishes are deficient in almost every requisite that should constitute a home for a Christian family in a civilised community. They are deficient in bedroom accommodation, very few having three chambers, and in some parishes the larger proportion only one; they are deficient in drainage and sanitary arrangements; they are imperfectly supplied with water; such conveniences as they have are often so situated as to become nuisances; they are full enough of draughts to generate any amount of rheumatism, and in many cases are lamentably dilapidated and out of repair.' And again:—'Modesty must be an unknown virtue, decency an unimaginable thing, where in one small

[1] Transactions, 1872, p. 22.

chamber, with the beds lying as thickly as they can be packed, father, mother, young men, lads, grown and growing up girls—two and sometimes three generations—are herded together promiscuously; where every operation of the toilet, and of nature—dressings, undressings, births, deaths—is performed by each within the sight and hearing of all; where children of both sexes, to as high an age as twelve or fourteen, or even more, occupy the same bed; where the whole atmosphere is sensual, and human nature is degraded into something below the level of swine. It is a hideous picture, and the picture is drawn from life.' . . . . 'The medical men, whose evidence I publish, assure me that cases of incest are anything but uncommon. We complain of the ante-nuptial unchastity of our women, of the loose talk and conduct of the girls who work in our fields . . . . here in cottage herding is the sufficient account and history of it all.' Nor is this 'hideous picture' exaggerated, though there are bright exceptions. We are apt to be misled by the picturesque appearance of villages, with their cottage walls clothed with creepers and climbing plants, roses and honeysuckles; but those who have taken more than a mere passing glance can testify to the deception. The surrounding soil is saturated with liquid filth of every description, which oftentimes oozes upwards through the ground-floor of the dwelling. The water supply is frequently derived from streams and stagnant pools, or ditches over which privies are built, and into which sewage flows, or drawn from wells receiving

the soakage of foul cesspools in their close proximity. The roof is often covered with putrid thatch, barely supported by rotten rafters, the boards and walls reeking with dampness and swarming with vermin. Here the sick and the well lie down together, and, when death comes, the living and the dead repose side by side. Let any one read the descriptions of peasant dwellings by the *Times* correspondent in the spring of 1874 [1]; and, making every allowance for possible exaggeration, a shudder of horror and pity must come over him that such a state of things should be possible in this nineteenth century, which prides itself on its advanced civilisation. Is there any wonder that drunkenness should prevail in such abodes? that, faint and depressed by the fetid atmosphere, the inhabitants should apply to stimulants for a temporary relief? that children born and bred amidst such surroundings should not turn out clean, honest, and pure-minded? The condition seems little improved since the day when Erasmus wrote to Cardinal Wolsey's physician that 'the houses were badly built and excluded wholesome air, that the floors were generally made of loam strewed with rushes, which, being constantly put on fresh without removal of the old, remained lying there in some cases for twenty years, with fish-bones, broken victuals, and other filth underneath.' [2] And what has been the result from this continual neglect of cleanliness and wholesome surroundings? We read of fifteen

[1] See *Times*, April 13 and May 26, 1874.

[2] Eras. Epp. lib. xxii., Ep. 12, col. 1140.

epidemics in the twelfth century, of twelve in the thirteenth century, of the terrible black death in the year 1348, of 'a score of epidemics with their accompaniments of famine and cattle plague' [1] between that date and 1485, when the great pestilence of the sweating sickness occurred. The sixteenth century was remarkable for its putrid malignant affections—'a century replete with grand phenomena affecting human life;' [2] and towards its close arose the series of pestilences which have been called the great plagues of 1593, 1625, and 1665. As each of these exhausted itself, the lesson which ought to have been learnt was forgotten.

In later years we have become accustomed to a host of diseases, which experience teaches us are more or less preventable: such as smallpox, measles, scarlet, typhus and typhoid fevers, dysentery, cholera, diarrhœa, diphtheria, whooping-cough, croup, puerperal fever, and many others. The spread of many of these diseases arises from single cases, and they are traceable, nearly always in the first instance, either to the drinking habitually water that has been contaminated by sewage, or to breathing foul air caused by overcrowding and bad ventilation, and the gases emitted by putrid sewage or other decomposing matter. There is, moreover, a still more insidious danger arising from decomposing animal matter than the foul gases which are at once perceptible to the senses. It is now well ascertained, that even when there may

[1] Dr. Guy. [2] Hecker.

be no smell, certain germs or ferments, generated by decomposition, but not of a gaseous nature, are given off. These contain solid elements of contagion, discoverable by the microscope, and capable of an indefinite power of self-multiplication. The knowledge of this fact is most important, because there is a prevailing notion that by deodorising, or destroying the smell, the danger of disease production is removed. This branch of chemistry is comparatively in its infancy; but great results may be expected from its further development, and the increasing interest taken in the subject by men of science.

It is possible that years may pass without any outbreak of these diseases in particular places which have the reputation of being very healthy; but if the surroundings contain the elements of disease, and one case should occur, the epidemic is pretty sure to be severe. The Registrar-General, in his report, August 1871, writing of cholera, says:—'It is now known that where a place is clean, where the waters are pure, where the people are not crowded, where good administrative arrangements are made for the early treatment of attacks in the first stage of diarrhœa, the epidemic is disarmed of nearly all its terrors.' And, speaking of the danger arising from impure water and air, Mr. Simon, the chief medical officer of the Privy Council and Local Government Board, has written, that 'there is the danger of water supplies which are in any (even the slightest) degree tainted by house refuse or other kinds of filth, as

where there is overflow, leakage or filtration from sewers, house-drains,[1] cesspools, foul ditches, or the like, into streams, springs, wells, or reservoirs, from which the supply of water is drawn, or into the soil in which the wells are situate; a danger which may exist on a small scale (but, perhaps, often repeated in the same district) at the pump or dip-well of a private house; or on a large, or even vast scale, in the source of supply of public waterworks. And, secondly, there is the danger of breathing air which is foul from the same sorts of impurity.'

The serious outbreak of typhoid fever at Terling, in Essex, where between December 4, 1867, and January 13, 1868, 208 persons out of a population of 900 were attacked, was shown to be connected with the pollution by sewage of wells from which drinking water was obtained. At Over Darwen, in the severe epidemic of typhoid at the close of the year 1874, which attracted the notice of the whole country, 2,035 out of a population of 10,051 were attacked, and 104 deaths occurred; and Dr. Steven, the Inspector, distinctly traced the origin to polluted water. A sewer empted itself into a field, through which passed the water-main containing the water-supply of the inhabitants. . At the point where the sewage came in contact with the water-pipe, a leakage in the pipe was found; and the supply of

[1] Except when making a quotation we prefer using the term private sewers' instead of 'house-drains,' the word 'drain' being applicable in strict accuracy to the drainage of land from the underlying water.

the water being intermittent, whenever the pipe became empty the liquid sewage was freely sucked up into the main, and passed on with the next supply of water to the people of Over Darwen.

Mr. Simon has well described typhoid as a Filth Disease. He describes the houses, groups of houses, the whole villages, sections of towns, and even entire and not small towns, 'where general slovenliness in everything which relates to the removal of refuse matter—slovenliness which, in many cases, amounts to utter bestiality of neglect, is the local habit: where, within or just outside each house, or in spaces common to many houses, lies for an indefinite time, undergoing fetid decomposition, more or less of the putrefiable refuse which house-life, and some sorts of trade-life, produce; excrement of man and brute, and garbage of all sorts, and ponded slop-waters, sometimes lying bare on the common surface; sometimes unintentionally stored out of sight and recollection, in drains or sewers, which cannot carry them away; sometimes held in receptacles specially provided to favour accumulation, as privy-pits and other cess-pools for excrement and slop-water, and so-called dust-bins, receiving kitchen refuse and other filth. And with this state of things, be it on large or on small scale, two chief sorts of danger to life arise: one, that volatile effluvia from the refuse pollute the surrounding air and everything which it contains; and the other, that the liquid parts of the refuse pass by soakage or leakage into the surrounding soil, to mingle there, of course, in whatever water the soil

yields; and in certain cases thus to occasion the deadliest pollution of wells and springs. To a really immense extent, to an extent indeed which persons unpractised in sanitary inspection could scarcely find themselves able to imagine, dangers of these two sorts are prevailing throughout the length and breadth of this country, not only in their slighter degrees, but in degrees which are gross and scandalous, and very often, I repeat, truly bestial. And I state all this in unequivocal language, because I feel that, if the new Sanitary organisation of the country is to fulfil its purpose, the administrators, local and central, must begin by fully recognising the real state of the case, and with consciousness that in many instances they will have to introduce for the first time, as into savage life, the rudiments of Sanitary civilisation.' [1]

Diphtheria is a disease peculiarly fatal to children, and owes its origin to the breathing an atmosphere tainted by putrefying sewage, or, as it is commonly called, sewer-gas. The Public Health Association of New York have come to the conclusion that it selects certain localities subject to 'certain conditions of soil, drainage, and sanitary wants of dwellings, which admit of preventive measures.' Mr. Oakeshott, the medical officer of health for Hornsey, has traced the cause to the escape of sewer-gas into houses. One case occurred at a small school held in a room ten feet square with a sink in it. The traps to this sink were defective, and the rush of sewer-gas into the

[1] Report of Medical Officer, New Series, No. ii. pp. 17, 18.

room was from two to three cubic feet per minute. Again, on examining the National Schools at Fortis Green, where the disease had appeared, he found a pit in the rear full of foul soil, the stench being very bad.[1] The married-quarters of the Royal Artillery on Woolwich Common, consisting of a row of badly-drained cottages, had to be cleared of their inhabitants in the spring of 1875, owing to the fatal prevalence of this disease.

But, in addition to these epidemic preventable diseases, there are some which may be called chronic, and are indirectly caused by unwholesome surroundings; and therefore are, to a certain extent, preventable. In the foremost rank may be placed scrofula, often hereditary, but which is called into activity by long-continued habits of filth, and often vice, indulged in from generation to generation—a disease from which those whose parents are too nearly related by blood to each other are seldom free. It is a state of constitution distinguished by peculiar liability to certain diseases. Consumption, too, the mortality from which amounts to more than one-tenth of the whole mortality of this country, is often occasioned by tainted air, polluted water, and a damp water-logged soil, especially when the sufferer is predisposed by scrofulous tendencies. Under-draining, by drying and ventilating the soil, as well as the better ventilation of dwellings, has greatly decreased this insidious disease. It has been confidently

[1] *Sanitary Record*, No. 37, p. 180.

asserted by a physician of great eminence, Dr. Wm. Budd, that consumption might be extinguished in ten years by the aid of certain restrictions and certain sanitary regulations. After the sewerage had been made effective the deaths from phthisis fell 49 per cent. in Salisbury; in Ely 47 per cent.; in Rugby 43 per cent.; and in Banbury 41 per cent. Dr. Lyon Playfair has informed us that 'dryness and well-ventilated rooms are powerful means to prevent, as they are to retard, consumption.'[1] Bronchitis and inflammation of the lungs are also largely due to the breathing impure air.

Now, in order to show how many deaths in the course of a year are to be ascribed to neglect of cleanliness and the want of sanitary precautions, it will be necessary, even at the risk of becoming somewhat tedious, to devote a short space to the consideration of a few statistics extracted from the 35th Annual Report of the Registrar-General for the year 1872, which, as it happened, was an exceptionally healthy year. We find that 492,265 deaths were registered in England and Wales—a number less by 22,614 than in the previous year, and less by 23,064 than in 1870. The deaths in 1872 being at the rate of 21·3 to every 1,000 of the population, or 1·0 per 1,000 below the mean rate of 35 years, which was 22·4 per 1,000. Now it is estimated by the Registrar-General that 17 annual deaths to every 1,000 should be the maximum; and in many healthy

[1] Transactions of Social Science Association, 1874.

districts the mortality is below that rate—in some as low as 15 per 1,000. Any deaths exceeding 17 per 1,000 annually may be termed unnatural deaths. It follows, therefore, that 5·4 deaths (according to the average of 35 years) in every 1,000 of the population are due to preventable disease. It is ascertained that the mean lifetime of people living in the least unhealthy districts is 49 years, whilst for all England it is 41 years. Thus life is abridged by full eight years, and half a generation is cut off before the 46th year has been attained. In the year 1872, 100,114 deaths were the results of causes which ought not to have been in operation; but the yearly average is about 120,000; and this annual sacrifice of life is not all that must be taken into consideration. Probably not one-tenth of those attacked by preventable diseases die. There remains the permanent disqualification of many for the duties of life; and the nation at large suffers an enormous loss from the waste of labour power, and deterioration of race both morally and physically, whilst on the families of the sufferers is entailed poverty and sickness. The pecuniary loss alone arising from these causes during the last twenty years has been estimated at three millions sterling every year.

The returns for the first quarter of the year 1875[1] show an astounding increase in the death-rate, it being 27·3 per 1,000, of which 28·9 occur in the

[1] See first Quarterly Report of Registrar-General, 1875.

urban population of about 13 millions, an excess of 2·3 per 1,000 over the mean death-rate of the corresponding quarters for the ten years 1865-74. In rural districts in a population of 10 millions the death-rate was 25·7 per 1,000, exceeding the average for the same districts in the ten previous corresponding quarters to the extent of 3·7 per 1,000. This increased death-rate doubtless was due to the great severity of the winter; but there is no decrease in deaths from preventable diseases, which are about on the usual average. The Registrar-General reports outbreaks of typhoid in various places, naming nineteen of them; and as the *Times* remarks in a leading article on this return:—'These places, or some of them, are probably in a fair way to be the "Over Darwens" of the future, unless the local rulers have the courage and wisdom to grapple at once with the evils to which the outbreaks point, and to enforce cleanliness wherever their powers extend. The occurrence of typhoid, even if the cases are only few in number, should now be regarded as a warning which it is absolutely criminal to neglect, and which calls not so much for panic-stricken precautions during the mere prevalence of the malady as for radical changes in the way in which the sanitary administration of the place is carried on. An extensive and fatal epidemic of fever, especially when it succeeds occasional cases in former years, will no longer be regarded by the public as a misfortune for which local government may be held in every degree guiltless.'[1]

[1] *Times*, May 18, 1875.

Enough has now been advanced to prove that there is urgent necessity for a stricter attention to matters relating to public health, not only by local authorities, but also by the central government and individuals. Many are fully alive to the importance of the question, and for them this chapter is not needed: but amongst the greater number of people there exists a culpable apathy or a lamentable ignorance; and therefore, before proceeding to point out what seem to us some of the simplest means of securing the object in view—viz., the highest condition of health and the prevention of disease—we have thought it advisable to dwell for a short space on the present condition of our population, hoping thereby to aid in eliciting a healthy public opinion in favour of practicable sanitary reforms.

CHAPTER II.

DWELLINGS, AND THE BEST MEANS OF SECURING PURITY OF AIR BOTH IN AND AROUND THEM.

HAVING in the preceding pages attempted to point out the defects and shortcomings of rural districts as regards the condition of dwellings, the want of a supply of pure water, and consequent disease, we propose in this chapter to consider what arrangements are most practicable, on account of their simplicity, to insure the highest degree of healthiness.

Now, although our remarks are intended to be applicable chiefly to the cottage dwellings of the rural labouring population, yet it must be borne in mind that these are not the only habitations in country districts. There are the country seats and farmhouses, the village parsonages and villas, all of which must bear a part in any scheme of rural sanitary economy, for they react upon each other for good or evil, according to the nature of their surroundings.

Some of the dwellings of our labouring population are so dilapidated that they are absolutely unfit for human habitations, and incapable of being made so. These should be pulled down, but the owners should be required to provide others suitable to the wants

of the people. There is frequently a readiness on the part of owners to pull down an unsightly building, but a disinclination to replace it by a decent dwelling. Such a course would only increase the already too prevalent evil of overcrowding, or would force those who were ejected to live at a distance from their work, thereby causing a waste both of time and strength; for it cannot be expected that a labouring man can have the same energy for his work if he has to walk some miles to and fro every day. This matter of having the cottages of labourers built near the scene of their labours is well worth the attention of both landowners and farmers from an economical point of view alone. But in many cases a dwelling can be renovated and repaired, and its surroundings so improved as to render it fit to live in, and the expense of a new building may thus be avoided.

The site on which a dwelling is to be built should be considered first. It is not always possible to choose this; but it is well to know that porous soils make the best sites; and gravels (free from clay), which do not rest upon non-absorbing rocks, rank first. The chalk formation is good; and next follow rocky and stony sites. Sandy soil is not unhealthy, but clay is the most unsuitable for various reasons; and, moreover, it is apt to slip and cause houses built upon it to settle and crack. Even if it is not possible to choose the site, by due attention to certain precautions the subsoil of the foundation may be made tolerably free from unhealthy influences. It may not, perhaps, be generally known that in most

soils there is a bed of underground water, or saturated subsoil, varying in its depth below the surface of the ground according to the season of the year, and on the same level as the standing water in the surface wells of the district. This subsoil water is always a source of danger to health, and doubly so when it becomes stagnant. A house sucks up all the poisonous emanations which rise, especially at night, when there is little ventilation. In order to prevent this stagnation and stop the water from rising above a certain level, the site of a dwelling and the surrounding ground should be thoroughly underdrained by ordinary land drainage-pipes, and in the case of a house already built, which is not so underdrained, the drain-pipes should be laid round the foundations, at a depth never less than five feet below the foundation. In clay soils these precautions are absolutely necessary. The soil will then be properly ventilated, and the ground air become pure. We may remark, incidentally, that if stables are similarly underdrained, the health of the horses will be greatly promoted. It is always a safe precaution to build on a layer of concrete, and in clay soils it is essential. When the walls are just above the surface of the ground a damp-proof course should be inserted both in the outside and inside walls. This course may be made either of sheet lead or of slates embedded in concrete or asphalte. The ground-floor should be a little above the level of the ground; and provision should be made for a free play of air underneath the flooring and above the damp-proof course. These precautions

having been taken, we shall have done our best as regards the foundation. The materials to be employed will of course depend on what are most easily and cheaply obtained in the immediate neighbourhood. Blocks of concrete are a valuable and lasting building material, and perhaps the best that can be used for cottages and small houses; but it would be unwise to employ concrete where stone or brick would be cheaper.

About 40 per cent. of the cottages of a village ought to have at least three bedrooms—none less than two; and one room on the ground-floor should be floored with wood. The continual use of a stone or brick paved floor for a living room is decidedly unhealthy. To secure a sufficient amount of air for the inhabitants, none of the rooms ought to be less than 8 feet in height, and their cubical contents should be from 600 feet to 900 feet for bedrooms, and from 1,200 to 1,500 for the living room. A proper regard to ventilation is most necessary; and this is a most difficult part of the subject, for it is next to impossible to insure it without the consent of the occupier. Any attempt at permanent ventilation is almost sure to fail, there being amongst our peasantry such a strong prejudice against fresh air, more particularly in sleeping rooms; so that if an owner or builder provides for its entrance the ventilator will almost invariably be found stuffed up with an old stocking or rag. Moreover, it must be confessed, that unless great care is exercised, in many of these arrangements there ensues a most unpleasant

draught, which is always to be avoided; and yet it is necessary that the air inside a dwelling should be continually replaced by fresh air from outside. The simplest, and, with regard to cottages, almost the only means upon which we can depend is the proper construction of the fireplace, the window, and the door; and we shall find that chimney ventilation will be frequently interfered with. There should always be windows to open on both sides of a house, and in every room a window which can be opened at the top as well as the bottom, the sashes being of equal size; where the windows are so small that this construction would be inconvenient, a window swinging on a horizontal pivot may be used. This is perhaps the best kind of window to replace fixed lattices in old cottages. In new buildings the window openings should not be less than one-tenth of the area of the floor; and if this rule be attended to, there will generally be room for a double-sashed window. Probably, in cottage-building, only one bedroom would be provided with a fireplace; the rooms without chimneys ought to be ventilated over the window, so that the incoming air may strike upwards. We feel sure that if, whilst building, due attention were paid to correct principles of ventilation, no discomfort would be caused to the occupier; and in time the feeling now prevailing among the peasantry that fresh air means a draught, and consequent rheumatics, would generally disappear. The roof should always be ceiled or underdrawn as a protection against heat and cold. Thatch should

never be used. Though picturesque, it breeds all manner of mischief. Where slates cannot be obtained easily, the roof should be tiled; and troughs should be placed under all the eaves to catch the rain-water, with a proper slope towards the down-pipe. In letting a cottage, the owner should insist upon the interior being lime-washed at least twice in every year, as well as after any sickness or death. The use of cheap wall-papers is much to be discouraged. They absorb dirt and infection, and afford a secure breeding-place for vermin. Once put up, it may be years before they are renewed; and during this time the seeds of incalculable mischief have every chance of developing. Green wall-papers are especially to be avoided, as they almost invariably contain arsenic, which is given off in particles sufficiently numerous to be injurious to health. Every facility ought to be afforded by owners to cottagers for procuring lime-wash, which may be coloured according to fancy; and if properly mixed will cause no inconvenience by rubbing off upon clothes. The difficulty is to persuade landlords and builders to act upon these suggestions. In many cases nothing less than an Act of Parliament will effect the remedy.

We now come to the most perplexing branch of the whole subject—the removal of refuse from premises; including in the term refuse, house-slops, ashes, and kitchen refuse, as well as the contents of privies and water-closets. If due care be taken that proper arrangements are made in this respect, experience has shown that the health and physique of

the inhabitants will be far above the average; but if this work is neglected or carelessly performed, all the seeds of mischief are at hand and a general low state of health will prevail, even if there be no outbreak of decided epidemic. But the conditions are favourable; and as a spark sets gunpowder in a blaze, so a solitary case of fever, perhaps imported from a distance by a stranger, may at any time cause great mortality and loss. So important is this matter, that we would suggest that before the building of any new dwelling is commenced it should be made compulsory on the builder to submit all the drainage plans and other sanitary arrangements of the house for the approval of the local sanitary authority. Matters would be greatly facilitated if plans, suited to the various conditions of their respective localities, were kept at the offices of the sanitary authority.

With regard to private sewers, the great principles to be observed are—first, their disconnection with the interior of dwellings; and second, their proper ventilation. We will turn our attention first to the discharge of kitchen refuse and slop-water. Every dwelling should be provided with a sink having a discharge-pipe emptying outside the house over a perforated gulley-plate, and not delivering into the body of the trap under this plate. Any foul air or gas which may escape through the trap, will then be unable to make its way through the sink-pipe to the interior of the house. For the removal of slop-water we would

suggest a basin-urinal either discharging over the same gulley, or a similar one in connection with the same private sewer. This urinal might generally be placed without difficulty in a private situation, and would be an inexpensive convenience, as well as a decent arrangement. The outlet of the basin should be perforated so as to arrest soap or any solid which might find its way into the slops. If this arrangement is impracticable, the house-slops should be poured down the gulley-hole; and the courtyard should be paved, or asphalted, with a proper slope towards the gulley, so that it may be impossible for any refuse liquid to remain on the surface. The gulley-plate should be immovable by the occupiers, and under it must be placed a trap which is intended to shut out by the interposition of water the sewer-gas generated in sewers. The trap commonly used is the bell-trap, which is generally worse than useless. The covering plate of this trap can be easily raised by the occupiers of the dwelling to allow vegetable parings and other solid refuse to pass down the pipe into the sewer; whereas these matters ought to be collected and disposed of among the ashes, or buried in the garden, if there be one. At the time the gulley-plate is lifted a free passage is given to the foul air of the sewer to escape, and it is often not replaced. These traps are also frequently allowed to become dry, or they may be broken, when the same escape of gas follows. They ought never to be supplied to new buildings; and the sooner they are replaced by a safer kind in old buildings the better

for the health of all concerned. We have not space here to enter into a description of the various inventions, more or less complicated, having for their object the prevention of the escape of sewer-gas. After carefully examining the merits of each, we have come to the conclusion that a syphon-trap, rather larger in diameter than the sewer with which it is connected, is the simplest and best; the plate over the entrance being opened periodically to remove grease and other accumulations which may have found their way through its holes. But we have not yet completely disposed of all danger from sewer-gas. If there should be a considerable amount of this foul air in the sewer it will bubble through the water in the trap, and make its escape into the outer air, causing great discomfort and danger to health. We must therefore ventilate the syphon; and this is easily done by introducing a shaft-pipe into the top of the bend. This should be carried up to the highest point of the roof, where it may discharge the foul gas into the open air without danger, provided the opening is not placed near a window. The down-pipes from the rain troughs under the eaves should never be used to ventilate sewers.

The trap is now ready to be connected with the private sewer: but before entering upon this part of the subject, we must devote a few lines to the discussion of the best sort of privy or water-closet. Let us say at the outset that it ought to be made incumbent on every builder to provide a separate privy or water-closet, as well as an ash-box, for each

dwelling. The use of these conveniences in common by the occupiers of several houses is a fruitful source of nuisance, and is injurious both to health and morals. The form of privy which has generally been in use in country districts is a wooden erection over a seat, under which is a pit or cesspool dug in the ground, open to the air, and without sewerage of any kind except the drainage afforded by the nature of the soil; and refuse of every sort is emptied into it. Occasionally we have found no seat, but simply a cross-bar, and no cesspit whatever, the excrement being allowed to accumulate on the surface of the ground, and diffuse itself and its odours for an unlimited time, or until it is required for manure. The state of wells from which the drinking supply is drawn in the neighbourhood of these so-called 'conveniences,' may be easily imagined. But abominable as they are, ignorant country people do not object to them. They have always been used to them. They give no trouble, they say, and cost no expense; in their ignorance making no account of the sickness and oftentimes death resulting therefrom. Often too these cesspools overflow into an open ditch, which finds its sluggish way, poisoning the air in its course, to the nearest brook. Vaults and covered cesspits, supposed to be water-tight, are in use in some places; but the liquid part invariably finds its way through the masonry into the surrounding soil. In our opinion, the Legislature should insist on the gradual abolition of all cesspools, and make it incumbent on all sanitary authorities to provide

means for the speedy removal from the premises of all putrescible refuse. This speedy removal is, in fact, at the bottom of the whole question; and in it lies the solution of the difficulty. How it may best be done will vary according to the special circumstances of each locality. After careful examination, and weighing impartially the merits of the different systems which have been proposed, we believe that, in the majority of cases, the earth system of Mr. Moule is the most practicable for country villages and scattered communities. But if there be an abundant water-supply available at a small cost, we must avow our preference for the employment of a modification of the water-closet, even in villages. It is the cleanest system; and private sewers are, if well constructed, the speediest plan of removal. Moreover, there are in every village certain houses of the better sort where there are water-closets, the discharge from which, cesspools being discontinued, must be provided for by the village system of sewerage. If then there be a sufficient supply, a uniform system of removal by water would be most economical and desirable. But we regret that this is not generally the case; and we must therefore fall back on the dry earth system, which we now proceed to describe, together with the necessary precautions which must be taken to prevent its becoming even a greater nuisance than the old-fashioned cesspools.

The principle of this system, introduced by the Rev. H. Moule, is that earth possesses a wonderful power both to deodorise and disinfect. It has also

the law of Moses in its support. It is employed with perfect success in many villages and public establishments. The earth to be used should be a loamy garden mould, well dried and sifted. The same earth may be used thrice, being sifted after each drying, and any refuse of paper or rag at once burnt. At the back of the closets there should be an opening for the supply of the earth, and the removal of the manure. A self-acting apparatus should be fitted to the seat, acting by the weight of the sitter, for the purpose of applying the earth after each use of the closet. One hundred weight of earth a week would, on the average, suffice for each closet. A galvanised iron receptacle, easily removable from the outside, should be placed under the seat. No privies of any kind should abut on the house; and in all at least one square foot of ventilating space should communicate directly with the open air. These precautions are absolutely necessary; for were it left to the occupier to supply dry earth, experience teaches us the duty would be neglected; and if it were at the option of each person to throw down a trowelful after using the closet it would rarely be done, and the place would become an intolerable nuisance. In fact this was the great objection to the dry earth system when first introduced, and a great prejudice still exists against it. Many owners have supplied their cottages with earth-closets, expecting their tenants to attend to them—a thing they have neither time nor inclination to do—and so have found a stolid opposition to their use. We

ourselves, in talking over these matters with cottagers, have heard very strong language condemning them, and wishes expressed for a return to the cesspool of their fathers, whence they could always ladle out the manure for their onions as required. In every case of this kind, we found the complainers were expected to keep these conveniences in order themselves. Those who are acquainted with the nature of the average English peasant, will know that this result was to be expected. When we come to the subject of scavenging we shall show how the difficulty may be obviated. Meanwhile, let us turn to the Report of the Rivers Pollution Commissioners. They say the dry-earth system 'is undoubtedly capable of being made an admirable scavenging expedient, so far as privy refuse is concerned.' Of this they convinced themselves at Broadmoor Criminal Lunatic Asylum and at Wakefield prison. The Commissioners also report that 'at Halton, Buckinghamshire, a pretty country village of fifty or sixty cottages, the roadside chalky soil is used successfully in the dry earth-closet, with which every cottage is provided. For this purpose it is screened and dried upon a kiln-floor about nine feet square; 100 bushels of coke being used in this way per annum for the fifty closets in the village. When hot and dry the earth is carried to the hopper in the back wall of each privy, which holds about 60 lbs.—enough for forty uses of the seat. The floor beneath is cemented so as to hold the liquid as well as the solid excrement; and the seats are hinged and on springs, so that on

rising from them a portion—about 1½ lbs.—is discharged from the hopper, and thrown upon the mass below. We came, without notice, one evening into the village, and examined about a score of these cottages, and found everything as clean and as sweet as possible. Seats and floors in front, hoppers and cesspool-floor behind, were all clean; and there was nothing to be seen but white dry earth, and no smell was perceptible. . . . Last year 70 tons of stuff were taken out of the privies of the fifty cottages; 30 tons, however, had been used twice, so that only 40 tons were available for use upon the land; and it had proved a capital fertiliser, producing an abundant crop of grass where the manure had been applied.

'In all these cases, however, the chamber-slops are kept separate; and independently of that, the success depends not upon the people using the privies, but upon an officer whose business it is to look after them and keep them clean. Even at Halton, one man is set apart for this work, who attends to the kiln, to the provision of dried earth, to the keeping the hoppers full, and to the removal of the manure. Elsewhere, we have known earth-closets introduced for the use of cottagers accustomed to the old privy-seat and cesspool; and requiring special service and attention, which the average man or woman will not give, they soon became filthy and offensive.'[1] It will be remembered that in our remarks at page 23 of this essay we have

[1] Rivers Pollution Commission, 1868, first Report, vol. i. pp. 49, 50.

provided for the separate discharge of house-slops and kitchen refuse.

Water-closets, depending upon individual attention to keep them in order, will as surely be failures as earth-closets. People neglect to flush them properly, and they become choked; and then they are complained of as being 'everlastingly a nuisance.' But, as we have said before, there are always some houses in villages, and those invariably the best, with water-closets; therefore, if there be a sufficient supply of water, we should prefer a uniform water system for the removal of refuse: but we must find a simple and yet effective plan for the cottage water-closet, for the peasant will never keep it in a clean and wholesome condition if left to his own resources. The self-acting tumbler closet appears to be the best for village use. It consists of a trough made of tiles under the seat, a swinging basin being placed at the upper end, into which water trickles; and this basin is so constructed that, when full, it turns over and washes the contents of the trough into the sewer. It can be so adjusted as to turn over at regular intervals; and about a gallon and a half of water per head in twenty-four hours is the quantity required. These closets keep very clean, and require fewer repairs and less attention than syphon or pan closets; but the water-supply must be carefully regulated, and the pivots on which the tumblers move must be properly constructed in the first instance.

The closets of which we have been treating are

out of doors; but whilst on the subject it may be as well to make a few remarks on those situated inside houses. In all such cases, if the water-closet be above the ground-floor, the soil-pipe should descend outside the house; and in building new houses this should be insisted on. A ventilating shaft, being in fact an upward continuation of the soil-pipe from just below the closet-trap under the seat, and of the same dimensions, should ascend to the highest point of the roof of the house, opening at as great a distance as possible from any window. Water-closets already in use without this ventilating shaft ought to be at once supplied with it. The reasons for these precautions are most important. If the soil-pipe is unventilated, it forms a shaft through which sewer-gas escapes, either by means of the closet-trap or through flaws in the soil-pipe when it passes inside the house; and so the sewer-gas is drawn into almost every room where there is a fire burning. It passes along between the joists and flooring, and may permeate the whole building; and this may happen when a plumber has certified that the soil-pipe is sound through its whole length, he having only satisfied himself that it is water-tight. It should be remembered that sewer-gas, especially when confined, attacks the lead of soil-pipes; and in a short time would corrode it into invisible holes, for the most part on the upper side of bends which are not touched by any liquid. A ventilated soil-pipe will last much longer than a similar pipe unventilated. Where space can be spared there should be an ante-

room to every water-closet inside a house. One other caution we must give. It is very much the custom to place a housemaid's sink in this ante-room, or in the closet itself, for the purpose of emptying chamber-slops, and these are made to discharge themselves into the soil-pipe of the closet. Nothing can be more dangerous; for a double means of escape is thus opened, which the sewer-gas will at once take advantage of to find its way into the house: the sink through which the slops are poured will at all times afford an easy passage for the foul air; and the rush of liquid, passing into the soil-pipe and driving the air before it, will suck the water out of the closet-pan, and leave it untrapped until its next use. To avoid this, the slops must be conducted by a separate pipe to discharge over an outside trap, as described above.[1]

As far as we have gone we have merely described the arrangements for depositing refuse outside dwellings, so that it may be in readiness for removal in the manner most convenient to the circumstances of each locality. It now remains to point out, first, the best and quickest mode of removal; and, secondly, the means of disposal least prejudical to health and comfort, and at the same time the most economical.

Now there are two modes of removal—by private sewers connected with the common sewer of the village, and by scavenging; and in every village both ought to be at work. It is to be hoped that, as sanitary knowledge increases amongst the community,

[1] Pp. 23, 24.

the principle will be extended that every village shall have its private and common sewers, and be regularly scavenged by men employed for that purpose by the sanitary authority. There is really no more reason why this should not be done in country districts as efficiently as it is carried out in towns. Scavenging must not be left to the occupiers. Dr. Acland, in a paper read at a congress of the Social Science Association, remarks :—'In a village, or in an isolated cottage, the labourer, often ill-fed, always overworked, either performs this duty himself, or it is left undone. He has to do it before his day's work, after it, or by losing it. What this implies if a man be not strong, those who know the people well can alone judge.

'The effect of this one circumstance is more injurious than can be readily estimated. It need hardly be repeated that it is productive not seldom of the most injurious effects on the health of the family. The water is poisoned, fevers are originated, and permanent ill-health is often engendered through recurring bowel attacks. But the more serious matter is that a generally untidy and miserable state of surroundings becomes the habit of the family. The children grow up with these associations, having no other home standard of decency. They have known and desire nothing else.'[1]

Wherever the water-closet system is in use there must be two separate sets of private sewers, one for conveying the household-slops to the common sewer,

[1] Transactions, 1871, p. 418.

and the other for conveying the water-closet discharge exclusively. Each of these private sewers should discharge into the common sewer through a flap-trap. Where the earth-closet only is used a sewer for the house-slops will alone be required. No sewer should be allowed to pass under a new house; but in old houses this cannot always be remedied. In such cases great care should be taken that the sewer is perfectly air-tight. All private and common sewers in villages should be made of impervious glazed stoneware pipes. It is a great mistake to make either a means for conveying away subsoil water; for when this has sunk below their level the liquid sewage will escape and soak the surrounding soil. For the same reason the use of old brick culverts as sewers ought to be forbidden, and impervious sewers should be substituted. Provision ought to be made for the interception of the subsoil water, before it can rise to the sewers, by means of land drainage-pipes laid at a sufficient depth for that purpose. Instances have occurred, as at Slough, where non-impervious sewers have tapped a spring and diverted the water from its natural outlets, the accustomed supply of the people being thus cut off. A great deal depends upon the careful laying of sewer-pipes; and it will add very little to their cost if they are furnished at intervals with access-pipes. These permit them to be easily examined; and in case of a stoppage, the remedy can be effected without disturbing the main channel. An instance was recently brought under our notice where a stoppage

had occurred in a private sewer. The workmen, in order to discover its whereabouts, broke the pipe; and after clearing away the accumulation, replaced the broken piece of piping, put some rough clay over it, and then earthed the whole over. No one overlooked them, and they knew no better. The state of the air and soil around that house after a little time may be imagined.

Where the water system is not generally employed, but only a few of the better houses have closets which discharge themselves into the sewer, it could not be considered unfair that there should be a special water-closet rate; because the increased amount of sewage will necessitate a larger sewer. The size of the common sewer will of course be regulated by the sanitary authority; but it is by no means safe to leave the size of the private sewer to the option of the builder. Many cottage dwellings are erected by speculative builders, whose sole desire is to make money at whatever risk to the health of others. A cottage or house is erected, and to all outward appearance the sanitary appliances have been duly cared for; but the underground arrangements, being out of sight, are frequently neglected. We would particularly call the attention of sanitary authorities to this class of builders. They are often the owners of houses on long leases, and in receipt of good rents, and should be made to comply strictly with sanitary regulations.

Storm-waters and rain-water from roofs ought never to be allowed to pass through the sewers without

control. The village street should be guttered; and where rain-water is not stored for household purposes, it should find its way to the nearest watercourse: but where practicable, it is convenient to have the power of flushing the sewers with it occasionally, by turning it through a gulley.

We have already advised the ventilation of private sewers close to dwellings; the same precaution must be taken with common sewers. In their course through a village a shaft for that purpose may be run up a tree, or the side of a house, discharging the foul air above the roof. When passing through fields a simple grating will be sufficient. By this means a current of free air will be introduced, which, together with the motion of the sewage, will tend to prevent stagnation. If sewerage works are properly constructed, the sewage will be removed to the place where it is to be disposed of before putrefaction has set in; and it ought not to be possible for any deposit to be made. It is stagnation and consequent putrefaction which generates the dangerous sewer-gas; and this must be guarded against carefully. These works are, however, often badly designed and worse constructed. The men entrusted with the execution are ignorant, and their work is covered up out of sight. Some sewers are so carelessly laid down that they are little better than cesspools; the sewage accumulates in some parts, and only the overflow passes on to the outlet. We cannot wonder then at prevailing prejudices, and the difficulty of convincing people of the necessity of a proper system.

They have known instances of failure, and take them to be the rule. They do not know that failure is almost always owing to faulty designs or bad construction, and not to a wrong principle. The inspection of sewerage works, both whilst in progress and after completion, should be considered one of the most important duties of the district surveyor.

But besides liquid refuse and the discharge from water-closets, there are accumulations of solid matters which in towns are removed by the dustman. At present, in rural districts, ashes, vegetable refuse, garden rubbish, everything that a cottager wishes to get rid of, is either thrown into the nearest stream, to the discomfort of those living lower down; or, if there be no stream, all is left lying about in streets and corners to pollute the air and breed disease. The duties of a rural scavenger should be as follows:—

1st. Where the dry-earth system is in use, he must visit every closet at least once a week, supplying the hopper with fresh dry earth and emptying the receptacle under the seat. There will be no smell when this is done, for the dry earth will have effected perfect deodorisation. He should also see that the self-acting apparatus of the seat is in working order. Where the trough water-closet is used, he will merely have to see that all is going on right.

2nd. He must empty all ashbins at least once a week.

3rd. He must raise the gulley-plate through which house-slops and kitchen refuse pass, and clear

the syphon-trap of any grease or other solids that may have got into it.

4th. He must see that the private and common sewers are kept clear and in working order.

The inspector of nuisances should be held responsible that these duties are properly performed.

In new buildings access should be provided for the scavenger without unnecessary interference with the privacy of the cottagers. There will be little difficulty about this in country villages. Indeed, it generally exists already. He should make his visits on a regularly appointed day each week, so that, being expected, he may cause as little inconvenience as possible. We would not recommend the sudden adoption of a new system, but if the sanitary authorities take due care that all new dwellings and closets be constructed and superintended on right principles, the improvement will gradually make its way; and the advantages being perceived by the neighbours, prejudice will vanish, and the new system will surely become a favourite. It would be well if a printed card were hung up in village closets with some plain instructions from the sanitary authority.

Drying sheds and a kiln for preparing the earth to be used in earth-closets should be erected in some central position in a rural district; and the heat used for drying should not exceed 150° Fahr. for earth that has already been employed, it being found that a greater degree of heat destroys some of the manurial properties. It may be remarked that a very slight smell is caused by the drying process,

but this is so trifling as to offend no one. One man with a horse and cart, and occasional help, easily to be procured from among able-bodied inmates of the Union workhouse, would generally be sufficient for an average village, unless the dwellings were very much scattered. But we shall be told that all this will cost an annual expenditure which rural districts can ill bear. It would be sufficient to answer that the advantage gained from increased health and energy would alone counterbalance the expense. But there will be a more immediate pecuniary return. Dr. Buchanan calculates, that for 1,000 inhabitants the outlay, in changing from the old-fashioned privies to the earth-closet system, need not exceed 250*l.*, and the weekly expenditure 4*l.* 15*s.* If the earth were used once its sale for manure would produce an annual income of 365*l.*, against an expenditure of 260*l.*; if used four times, it would sell at 3*l.* a ton, and produce an income of 600*l.*, with an expenditure of 244*l.* We think that Dr. Buchanan considerably over-estimates the value of the manure; but we also believe that Dr. Vöelcker, the eminent agricultural chemist, errs as much in the other direction. He estimates the value of a ton of the manure at 7*s.* 6*d.* only; and seems to be of opinion that the sole test of value is the amount of ammonia contained therein. We do not pretend to dispute the correctness of his analysis, but from practical experience we know that the contents of earth-closets are very valuable for garden manure; and we have little doubt that they might be used by farmers with great advantage in

cultivating root-crops and cabbages. In all probability the value varies from 1*l.* to 30*s.* a ton, which on Dr. Buchanan's estimate of expenditure would about pay the costs.

Many cottagers help out their rent by keeping pigs. Where there are gardens, and the pigsty is at a sufficient distance from any dwelling, no objection need be made; but there is great danger of pigs becoming a nuisance. We have seen in a cottage garden a pigsty draining into an open pit not twenty feet from the house, the same pit receiving the overflow from an old-fashioned privy and the sweepings of the sty—the inhabitants all the time attributing their frequent ailments to any cause but this. No one should be allowed to keep pigs without the permission of the sanitary authority, the arrangements of the sty being open to inspection; and on the inspector of nuisances making an unfavourable report, it should be in the power of the authority to order their removal, sufficient notice to that effect being given.

The cottages in most villages have some sort of gardens, and every encouragement should be given for their cultivation. Cabbages, onions, leeks, potatoes, lettuces, carrots, beetroot, and other vegetables thrive well on earth-closet manure, and require no other. It is also well that people should know that certain plants and flowers are more useful than others in purifying and disinfecting the air; and therefore they have a sanitary value in addition to their beauty. Dr. Daubeny and Professor Man-

togazza, of Pavia, have shown that the leaves of growing plants give off ozone very considerably. We must briefly explain here that ozone is of a gaseous nature, and is the great scavenger of the air. Dr. Daubeny, speaking of 'the uses which ozone subserves in the economy of nature,' says: 'When we consider the rapidity with which any organic matter, dead or living, undergoes a slow combustion in its presence, it seems reasonable to conclude that this principle is an important agent for destroying putrescible animal and vegetable matter, and thus for restoring to the atmosphere its purity.' Hyacinths, mignonette, mint, lavender, heliotrope, narcissus, cherry, laurel, and most sweet-smelling flowers produce ozone in large quantities under exposure to the sun's rays. Here then is an inducement on sanitary grounds to make cottage gardens attractive and pleasant.

Cottages with the appliances we have described might be erected at an average cost of 110*l.* each; and if built in blocks of two, three, or even six, a great saving would be effected. Nothing is more pernicious than the custom of giving labourers cottages either rent-free or at a mere nominal rent, in lieu of more wages. The labourer does not feel at liberty to complain of his dwelling when he has it on these terms; and the owner, getting little or no rent in a direct way, and forgetting that he has the labour of the occupier instead, expends no money on repairs, and the cottage falls into decay. Let the labourer be paid in money the full value of his

work, and then he will be able to pay a fair rent. We do not for a moment wish to assert that cottage building will be a lucrative investment in the direct sense of the word. Probably it will pay from $3\frac{1}{2}$ to 4 per cent., and as most landowners are content with from 2 to 3 per cent. returns from land, there ought to be no obstacle on this score. The ownership of property entails certain duties, and none are more pressing than the provision of decent dwellings for the labouring population. As time goes on, let us hope that all landowners and employers of labour will see that it is their interest as well as their duty; and in place of the miserable hovels now too frequent, we shall find healthy and picturesque cottages.

CHAPTER III.

DISPOSAL OF SEWAGE AND THE POLLUTION OF RIVERS—THE STANDARDS OF PURITY.

In the preceding chapter we have pointed out how solid house refuse may not only be got rid of, but also made useful and reproductive. We have now to turn our attention to the disposal of liquid refuse or sewage—a branch of the subject before us which is intimately connected with the pollution of rivers; for, as is known to all, it has been for years the custom to consider rivers and watercourses the natural channel for the removal of every description of refuse—not considering that we are throwing away what might be turned to good account for agricultural purposes. And this wastefulness is not merely a loss to the wealth of the nation, but positive harm is caused to an incalculable extent by the pollution of river waters. Mansion, mill, and cottage, all contribute to the nuisance. In the second report of the Royal Sanitary Commission we read that, 'encouraged by the facilities which the Public Health Act, 1848, offered, the towns began to carry out large works for their own sewerage and drainage, taking the rivers, on which most of them had been situated for water supply, as the means of discharging what they simply

looked upon as refuse; regardless of the loss to themselves of pure water, of the waste of sewage, and of the injury to the inhabitants of the valleys through which these poisoned rivers were afterwards to flow.

'Thus men and cattle suffered by drinking from a polluted stream, which should have afforded a pure supply to both town and country, whilst the towns were throwing to waste that which should have been employed as a valuable manure by the country; and the only remedy was by costly and tedious actions at law and suits in Chancery.'[1] The Commissioners appointed in 1868 to inquire into the best means for preventing the pollution of rivers summarise the existing state of affairs as follows:—'The effect of this conversion of the rivers into common sewers is most injurious. All complain; even those who, while suffering from the inconvenience and annoyance which such a state of things entails, add to the nuisance by themselves following the general example. While they whose property happens to lie on the stream, even many miles below the towns, are sufferers in a variety of ways. Are they farmers? Their cattle cannot drink of the stream passing through their meadows. Are they dwelling on or near the bank of the river? They are driven from home by the stench, which renders the place unbearable. Are they compelled by duty to remain on the spot? They are subject to perpetual annoyance, and, as alleged, in many instances to ill-health. Have

[1] Vol. i. p. 8.

they property? Its value is often diminished, a house remains tenantless, land is unsaleable except at a reduced price.'[1]

Until we have dealt with the disposal of sewage, we shall confine our remarks to the pollution of rivers by excremental refuse. The Commissioners express themselves very strongly on the wastefulness of turning into rivers sewage which might be employed in fertilising land. They say: 'Every one is familiar with the idea that the fertility of a farm depends very much on the quantity of live stock kept upon it.' 'Nearly one-third of the live stock of this country is mankind! In 1869, there were in England 20,658,599 of "man;" and he consumes not only the produce of all these acres (23,370,502), and of all the cattle, sheep, and pigs which are maintained upon them, but imported food as well, to the extent of two-fifths of the estimated quantity of our home-grown wheat, and probably one-twentieth or more in excess of our home-grown meat. A creature of such great powers of consumption ought, according to all the analogies, to be of corresponding agricultural value as a fertiliser. If, leaving out of consideration the products of respiration, excrement be just the food of an animal *minus* its growth, then, on the ground of both these elements of the calculation, man ought to be the very best farm stock we have. He is not only a much better fed animal than a sheep, but he takes much less out of his food. Bread and beef are better food than grass and turnips,

[1] First Report, vol. i. p. 12.

and the growth taken out of these several rations is much less in the former case than in the latter. The population fed on bread and beef does not increase in number, and that is, virtually, in total weight, more than two per cent. per annum; whereas the "population" fed on grass and turnips increases in weight at least 30 to 50 per cent. within the year. A sheep builds its whole weight of body out of the food of 18 months. The average age of man in England is rather more than 40 years, and the weight of his body at death is all that he has saved out of all the food that he has consumed during the whole period of his life. On every ground therefore we ought to anticipate the superiority of man to sheep as a manure-producing animal for farm use.'

'The sheep is the best live stock known to English agriculture, and man is virtually good for nothing. What would the English farmer do without his flock? Over all the oolitic, chalk, and gravel soils—the light land districts of the country—to be deprived of the assistance of the sheep would be the ruin of the agriculturist. Man, on the other hand, is, as live stock, we repeat it, virtually useless to him. The excrement of a sheep is worth, at least, five shillings a year to the farmer. In South Lancashire the excrement of man does not realise fivepence per annum individually.'[1] We have then to find out whether there is not some simple way of disposing of the sewage of country districts, so that whilst extract-

[1] First Report, vol. i. p. 72.

ing for the benefit of the soil all that is valuable, the liquid that flows away may be so far purified as not to cause undue pollution. In towns the great difficulty to be contended against is the immense volume to be got rid of. In villages, on the other hand, the quantity will be comparatively small; and therefore large works, such as are necessary for towns, would be out of place. We need not then occupy our limited space by discussing any of the numerous schemes which have been proposed for the benefit of towns. The only plan that appears to us at all practicable in country districts is irrigation, combined with 'intermittent downward filtration;' and we shall be surprised if eventually the towns do not also find it their only resource. We do not mean that every village should set up a 'sewage farm;' but that, on a small scale, suited to their requirements, they must work on that principle. We will in the first place try to show the great advantages to be obtained from its adoption, and then describe the simple and inexpensive means which we would recommend to rural sanitary authorities, in order to carry it out effectively.

The phrase 'intermittent downward filtration' owes its origin, we believe, to Professor Frankland, one of the Rivers Pollution Commissioners, and a most eminent chemist. The three words convey to the mind a clear definition of the whole principle of the process; and it is no doubt owing to this fact that the happy expression has been adopted universally. Professor Frankland instituted a series of

experiments (which are fully described in the Report of the Commissioners, vol. i. pp. 60–70); and these experiments proved most clearly, that, for efficient purification by filtration, it is essential that atmospheric oxygen[1] should have frequent and free access to the interior of the filter, that is, we must aërate our land; and even then we must not overtax its powers. In short, he proved that the power lay rather in the air than in the earth; but he also pointed out that the total quantity of sewage which might be purified in the course of a year by one acre of porous earth was enormous; and that this purification might be just as complete although the earth was unassisted by vegetation of any kind; the process which goes on in the absence of vegetation being, in fact, one of oxidation;[2] or, as the French term it, of nitrification, that is, of conversion from an organic and putrescible to an inorganic and non-putrescible form. This question of nitrification is one that all the keenest chemists and philosophers of France have long worked at and been puzzled by.[3] Professor Frankland's experiments show that different classes of soils, though porous, have not the same powers of purification, probably because

[1] *Oxygen* is the most essential constituent of the air we breathe to the support of animal life, and hence it was called vital air by the earlier chemists.

[2] *Oxidation* is the term applied to the union of any substance with oxygen, the substance being then said to be *oxidised*.

[3] See a paper on the Pollution of Rivers, read at the Congress of the Social Science Association at Plymouth, in 1872, by Mr. Hope, V.C.; Transactions, p. 346.

of their different chemical constitution; but he concludes confidently that the results obtained by the filtration of sewage through various materials leave no doubt that this liquid can be effectually purified by such processes; and that probably any variety of porous and finely-divided soil may be employed for that purpose. It appears also that if land be not overdosed with sewage it will retain its power of purification for a long, if not for an unlimited period, and its pores will not become clogged up. With a properly constituted soil, well and deeply drained, nothing more would be necessary than to level the surface, and to divide it into four equal plots, each of which in succession would then receive the sewage for six hours. The effluent water, after the experimental filtration of sewage by Dr. Frankland, was analysed, and found to be sufficiently purified to be admitted into any stream without any apparent pollution of the latter; when undiluted it was clear and colourless, or nearly so, and sparkling. Only as a source of drinking water could a stream, into which such purified sewage flows, be condemned. But there is one great objection to the adoption of this system in its simplicity. It would be unremunerative, the whole of the manure ingredients of the sewage being absolutely wasted. If, however, sewage be used in irrigation combined with intermittent downward filtration, we shall succeed in turning it to profitable account. In this process the surface used must be carefully prepared to allow of the equal distribution of the sewage, and the ground itself must be thoroughly underdrained; for, though in irrigation

the roots of plants would retain and assimilate a considerable portion of the matter both in suspension and solution, yet this alone would not be sufficient to render the water flowing off the surface so pure that it might be admitted with safety into streams. Care must be taken, therefore, that not a drop of sewage runs to the outlet off the surface. All must pass through the land, and therefore underdrainage is necessary to make the soil porous, so that, when sewage is applied by irrigation, it may not only flow over the surface, but sink through it to a considerable depth before reaching the surface springs; and, as no vegetation will prosper in a water-logged soil, the irrigation must be intermittent. The air will then follow the sewage down through the pores of the soil, and it will be properly oxidised. We shall thus have both a horizontal and vertical system of filtration; and this is what we mean when we recommend irrigation combined with intermittent downward filtration. 'Sewage traversing the soil undergoes a process to some extent analogous to that experienced by the blood passing through the lungs in the act of breathing. A field of porous soil irrigated intermittently virtually performs an act of respiration, copying on an enormous scale the lung-action of a breathing animal; for it is alternately receiving and expiring air, and thus dealing as an oxidising agent with the filthy fluid that is trickling through it. And a whole acre of soil three or four feet deep, presenting within it such an enormous lung surface, must be far superior as an oxidiser for

dealing with the drainage of 100 people, to any filter that could be practically worked for this purpose.'[1] And the great advantage is that the manure is not wasted, but is transformed, first into vegetable life, and thence into animal life again. It is also worthy of note that in winter time, when vegetation is dormant, the filtering soil will retain the manurial properties of the sewage in readiness for the spring crops. As the Earl of Essex said in his evidence before Dr. Brady's Committee, 'put it on when you like, it remains in the soil till it is wanted by the plants;' the effluent water, meanwhile, will pass as before. It has been objected, that this process must cause foul stenches, and be injurious to the health of those residing in the neighbourhood of sewage works; but experience has shown that, where the work is properly performed, no discomfort arises from smell, and the health of the inhabitants in no way suffers. At Barking, at Norwood, and at Beddington large volumes of sewage are so disposed of without any evil results. At Beddington and Norwood, indeed, there has been a diminution of sickness since the establishment of the sewage farms; and at Norwood a public footpath passes through the fields, which is frequented by hundreds of persons for recreation and amusement, especially on a Sunday. The persons so using the footpath have frequently been surprised when they have been told that their walks for pleasure have been taken through the sewage farm

[1] Rivers Pollution Commission, First Report, vol. i. p. 71.

of the Croydon Local Board of Health. The path is much more frequented than other footpaths in the neighbourhood; which would not be the case if the fields were the nuisance they are supposed to be. But everything depends on the process being well managed. The sewage must be quickly conveyed whilst fresh through the sewers, and disposed of before putrefaction has time to set in. All stagnant pools and ditches must be avoided; and the sewage must flow evenly over the surface, the soil being allowed sufficient intervals of rest; and then, if properly underdrained, it cannot become water-logged.

But how can this system be efficiently and profitably applied to village communities? We believe the process may be adapted even to a single house; though probably for small isolated dwellings the dry-earth closet is the best, leaving only house-slops to be disposed of as liquid refuse. The chief obstacle to be overcome is the small and irregular flow of sewage, which merely dribbles along the sewers from small villages; and has hardly force enough, if left to itself, to perform the operation of irrigation. It is also necessary to economise labour as much as possible. An apparatus, patented by Messrs. Bailey Denton and Rogers Field jointly, which was exhibited at South Kensington, will meet these difficulties. Mr. Field had previously invented a self-acting Flush Tank for the disposal of slops from separate dwellings. The 'Flush Tank' discharges itself by a syphon when full, without any other predetermination of quantity than that dictated by convenience

of size. It is admirably adapted for collecting and retaining solid matters (to be afterwards removed by the scavenger), and for flushing sewers with the liquid after the solid matters have been separated from it; but we do not approve of Mr. Field's plan of disposing of this liquid by sub-irrigation, which is entirely opposed to the principle of intermittent downward filtration. Instances may occur of village 'Ends' and 'Greens,' and even isolated dwellings remote from the village system of sewerage; and disapproving as we do of sub-irrigation, we have still to solve the difficulty of disposing of the liquid refuse. Mr. Bailey Denton has improved upon Mr. Field's 'Flush Tank,' and the result is a self-acting Sewage Regulator, which they have jointly patented under the name of the 'Automatic Sewage Meter.' In the case of the Regulator, it is a *sine quâ non* that the Tank shall collect from towns, villages, or dwellings, where it is used, say a third, a half, or a whole day's sewage, so as to overcome the difficulty of dealing with an outflow which is comparatively small and variable. Without this regulation it has been found that sewage varying in quantity cannot be applied to land with a certainty of being cleansed. To effect this cleansing, a certain quantity of sewage, applied on the surface, must filtrate through a certain quantity of soil. And for this purpose no arrangement appears so simple and so promising of success as that of a tank, or system of tanks, of a proper size, furnished with a syphon or syphons (as in Mr. Field's 'Flush Tank'), which will discharge

the contents automatically directly the sewage rises up to the crown of the syphons. By this combination the following objects are gained :—(1) of collecting at short though unequal periods a *certain quantity of sewage*, which can be favourably dealt with whilst fresh ; (2) in discharging *automatically* a certain quantity of sewage, and thus allowing of its application to the *precise quantity of land* which will permanently cleanse it ; and (3) in applying it *intermittently*, so as to secure the oxidation of the putrescible matter. This simple combination, termed the 'Automatic Sewage Meter,' appears then to us to meet all the requirements of rural districts for ultimate disposal of liquid refuse, whether consisting of house-slops or water-closet sewage. Provided always that where the water-closet system is in use there must be two distinct sets of private sewer-pipes to convey the two forms of liquid refuse to the common sewer where it is practicable, and thence to the 'Automatic Sewage Meter ;' or, where the dwellings are remote from the village sewer, to convey these liquids directly and separately into the meter tanks. One of these meters has been in use about four years in the hamlet of Eastwick, near Leatherhead, in Surrey ; and its operation, particularly as part of the sanitary arrangements of the village, may there be studied very usefully. Eastwick contains thirteen houses, including the mansion of the proprietor and a farm homestead ; and it has a population of about 145. Four water-closets and five earth-closets exist for the use of the mansion and its precincts ; and one

water-closet and three earth-closets for the farm. The common privy is in use among the cottagers, with the exception that it has a water-tight receptacle underneath. Mr. Bailey Denton carried out a scheme of sewerage to dispose of the liquid refuse of the hamlet. The tank is in two compartments, to admit of cleansing without entire disuse. It contains 500 gallons; and fills and discharges, in ordinary dry weather, three times in two days. The several discharges are directed successively on different portions of a plot of grouud prepared for the purpose; and which, measuring 3 roods 3 perches, serves ordinarily for the effective and profitable utilisation of the whole liquid refuse of the several cottages, the mansion, and the farm. The sewage of the latter includes the flow from cattle-sheds and stables, in which from 15 to 20 animals are always present, besides about 30 head of horned cattle, and 30 horses at intervals. All this passes to the tanks, as does also the liquid manure from a large piggery.

Luxuriant crops have been grown upon the irrigated land, last year's crop consisting of the thousand-headed cabbage. Of this crop, Mr. Hutchinson, the steward of the estate, says:—'Besides thriving so well upon the sewage, it is an excellent food for milch cows, being less strong in taste than the drumhead, and not having any but a good effect upon the milk. The thousand-head can also be used as human food. I estimate the value of the crops obtained at 25*l.*, or at the rate of 32*l.* 10*s.* per acre; and the outlay in attendance upon the land and

regulator ("meter") I put down at 7*l.* 16*s.*' Mr. Hutchinson also says in a letter to the editor of the *Sanitary Record*: 'From the regulator the sewage is run on to land, which is thrown into ridges and furrows, its application being regulated simply by "stops" set in the furrows.' The land irrigated is within 300 yards of the mansion gardens, but no nuisance is experienced from it.

The cost of the Eastwick sewerage was as follows:—

	£	*s.*	*d.*
To payment for labour	179	4	0
„ pipes	103	7	2
„ stone, lime, cement and sand . . .	12	14	0
„ iron and lead work .	20	5	1
„ carriage of materials .	1	9	1
Travelling and incidental expenses .	3	12	0
	£320	11	4

Messrs. Denton and Field's inventions are described at the end of Appendix VII. to the New Series, No. II., of the Reports of the Medical Officer of the Privy Council and Local Government Board. Plans of Mr. Field's Flush Tank and of the 'Automatic Sewage Meter' are also given, as well as a map of the sewerage of Eastwick. We have taken our description of the system employed in this village chiefly from that source, and would recommend any one interested to refer to those reports. The profits at Eastwick are about 5 per cent. In some places there may not be a sufficient fall in the ground to allow the sewage to flow evenly over it by the force

of gravitation. Here it might be necessary to place a tank large enough to hold a day's sewage, and then force it over the land by means of a chain-pump. These matters must be left to each sanitary authority to manage for itself. But land will be required, and at present there is not sufficient belief in the use of sewage as a manure amongst agriculturists generally to induce them to apply it to their farms. It has been suggested, and we believe it would prove advantageous from a money point of view, to apply sewage to garden allotments, it being peculiarly adapted to vegetables. The meter would apportion a sufficient quantity to each plot; and by giving each a period of rest, the intermittency, which is essential to successful cultivation, would be secured. It would also be well for the sanitary authority to retain in their own hands a certain portion of land adjacent to the allotment plots. This might be used for grass crops and roots, and would be available in case the allotments were in danger of being over-sewaged; and it would also allow them longer periods of rest. The ground so employed should all be underdrained. Before concluding our remarks on the disposal of sewage, let us add one word on the advantage of combining beauty of landscape with useful sanitary measures. Certain trees, more especially firs and pines, absorb an immense deal of moisture, and thus greatly aid in drying the ground. If planted in clumps or in belts on irrigation grounds, they would diminish the amount of effluent water. The plane and elm also are most useful, as well as

ornamental. They absorb by their foliage the poisonous malaria arising from decomposing animal and vegetable matter, and they take up from the soil the liquid refuse, giving off at the same time for our use the purifying ozone; and whilst cooling and sweetening the air, they please the senses.

But sewage and house refuse are not the only causes of river pollution. The disposal of the refuse from factories and mines is also to be considered; for this, when turned into rivers and watercourses, is often as great an offence to the districts, through which rivers so polluted pass, as sewage. We have not space here to describe the peculiar kinds of refuse resulting from the various manufactures and mines of this country. We propose therefore to deal with the subject generally. As before, we have both solid and liquid refuse to contend with. Solid refuse from factories consists mainly of ashes and cinders. In many factories several thousand tons of coals are consumed annually; and out of every eight tons of coal one ton of ashes has to be got rid of. Hitherto this has generally been shot into the river; and in consequence the bed of the stream has gradually silted up—*i.e.* has been raised above its natural level. Great shoals of black mud appear below the mills, the river is often diverted from its course, and in flood time, owing to the stream being thus artificially shallowed, there is not room for the flood waters to pass off, and great injury is inflicted on river-side villages and towns. The meadows also, on the subsidence of the flood, are covered with a de-

posit, which makes them unfit for pasture for a considerable time.

Cattle have died after grazing upon meadows covered with colliery detritus; and instances were reported to the Rivers Pollution Commissioners, in which as much as two quarts of coal-dust were found in their stomachs. This dust is said to cause internal ulceration and violent purging, and is ultimately fatal.

The liquid refuse from factories consists of suspended and dissolved matter. The suspended matter deposits itself as mud on the river-bed, much in the same way as solid refuse, only in finer particles, and with much the same results, except that it is more easily disturbed by floods. Also when the weather grows warm it often becomes putrid, sending out nauseous gases, which rise to the surface of the river in bubbles, and sometimes buoy up large flakes of black and filthy mud. Nearly every manufacturing process causes an effluent refuse, containing polluting matters in solution as well as suspension.

The liquid refuse from mines contains polluting matter chiefly in suspension, but in some of the water discharged from collieries, and from mines where white arsenic is manufactured, polluting matter in solution is present. In discussing the standards of pollution, we shall refer again to these matters.

Water is so essential to the operations of a manufacturer, and his requirements in this respect are often so great, that we generally find factories on the banks of a stream, or in its immediate neigh-

bourhood. In truth, they could hardly be worked elsewhere; and to diminish their supply of water would cause great damage. Manufacturers are therefore allowed to build weirs for diverting some of the river water, in order to supply their mills; and the refuse they pass out through the mill-tail, in a polluted condition, to join the river lower down. These weirs, moreover, by making still pools above them, give a resting-place to all the solid rubbish brought down the stream; and the water being dammed up by them above its natural level, land drainage is rendered more expensive and difficult, and an injury is inflicted on agriculture. The manufacturer also frequently allows the excrements of his workpeople to drain into the river. From all this we see that it is the village or factory nearest the head of a stream which alone gets the water in its natural state; and in its course, each town, village, or factory pours in polluting refuse for the use of those lower down the stream. Everyone complains of the water above him; but, utterly indifferent to the fate of those below him, he contributes to increase the nuisance himself. We have been thus particular in pointing out how manufacturers habitually disregard the comfort and convenience of others, because we wish them to take into their consideration that they are allowed privileges for carrying on their operations, which are opposed to the interest of others of the community, and are thus enabled to realise great profits. It surely, therefore, is not unreasonable to expect them to try and remedy these nuisances, even at some

expense to themselves. They allow that it would be a great advantage to them in their business if the river waters could be restored to their natural purity. From the evidence of thirty firms, it appears that such a restoration would be worth to them alone more than 10,000*l.* a year.[1]

The Rivers Pollution Commissioners, after careful research and many experiments, have been able to report that efficient remedies exist and are available in all cases; and they have indicated how each specific form of pollution may be obviated and got rid of in a manner which shall not be unreasonably expensive to the manufacturers, and in very many cases not expensive at all, but profitable. They state that, 'whether in the "sewage of towns and populous places," or in "the refuse arising from industrial processes and manufactures," that which might have been expected to present the greatest difficulty to the improvement of the condition of the river waters into which these drainages have been discharged, has been found amenable to comparatively easy treatment; and the nuisance which it creates may be easily prevented, "without risk to public health or serious injury to such processes and manufactures." The standards we have suggested respecting matters in solution in drainage waters of all these kinds are applicable without excessive cost or difficulty: and all the manufacturers of the country, as well as all the local authorities who are responsible for the

[1] Rivers Pollution Commission, first Report, pp. 96, 97.

nuisances which arise from the drainage of towns and populous places, may be at once brought under the rules we have recommended, without injury, often indeed with great benefit, to themselves.'[1]

The standards of purity, below which no liquid should be admissible into any river or stream, were framed on the consideration that they were necessary to guard the manufacturer against any arbitrary exercise of authority; and also to secure an efficient and uniform check upon the pollution of rivers throughout the country. The following standards are those recommended by the Commissioners:—

(*a*) Any liquid which has not been subjected to perfect rest in subsidence ponds of sufficient size, for a period of at least six hours; *or* which, having been so subjected to subsidence, contains *in suspension* more than one part by weight of dry organic matter in 100,000 parts by weight of the liquid; *or* which, not having been so subjected to subsidence, contains *in suspension* more than three parts by weight of dry mineral matter, or one part by weight of dry organic matter, in 100,000 parts by weight of the liquid.

(*b*) Any liquid containing, *in solution*, more than two parts by weight of organic carbon, or ·3 part by weight of organic nitrogen in 100,000 parts by weight.

(*c*) Any liquid which shall exhibit by daylight a distinct colour, when a stratum of it one inch deep

[1] Rivers Pollution Commission, Fifth Report, p. 48.

is placed in a white porcelain or earthenware vessel.

(*d*) Any liquid which contains, *in solution*, in 100,000 parts by weight, more than two parts by weight of any metal except calcium, magnesium, potassium and sodium.

(*e*) Any liquid which, in 100,000 parts by weight, contains, *whether in solution or suspension*, in chemical combination or otherwise, ·05 part by weight of metallic arsenic.

(*f*) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than one part by weight of free chlorine.

(*g*) Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

(*h*) Any liquid possessing an acidity greater than that which is produced by adding two parts by weight of real muriatic acid to 1,000 parts by weight of distilled water.

(*i*) Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1,000 parts by weight of distilled water.

(*k*) Any liquid exhibiting a film of petroleum or hydrocarbon oil upon its surface, or containing, in suspension, in 100,000 parts more than ·05 part of such oil.[1]

[1] Rivers Pollution Commission, Fifth Report, p. 49.

These standards are expressed in such scientific language that manufacturers are led to think that they are more severe than is really the case. We proceed to discuss them in order to show their applicability.

Standard (*a*) is a modification of that originally suggested in the first Report relating to matters in suspension in foul waters. The exception, which the Commissioners found necessary, exists only in some of the mining operations of the country; and having found that some of these industries would suffer by the application of the original standard, it was modified by the addition of an alternative condition, so as to cover these cases, and also leave any other industry at liberty to adopt it. This standard as it now stands is by no means excessively stringent. No river except in a state of flood contains anything like this degree of impurity. The standard refers to the state of discharges into the river which are under the control of manufacturers. But it will be said, a manufacturer, when the river is flooded, may receive water more impure than allowed by the standard; and it is a hardship to make him discharge it purer than he received it. In answer to this we say, that rivers are now so polluted generally, that the manufacturer frequently receives the water too foul for use, and is obliged to have depositing reservoirs in order to render it available. Now if all manufacturers were compelled to discharge the water according to the standard, each would receive it so much purer than at present that the process of purification before use would not be needed to near so great an extent.

Standard (*b*) is aimed at pollution by sewage, and is a very mild standard for the effluent water from defecated sewage. Dr. Lyon Playfair has couched this standard in more popular language as follows:—'Any liquid, sewage or drainage, containing in solution in a gallon more than one grain and a half of organic carbon, or more than two-tenths part of a grain of organic nitrogen.' The presence of nitrogen is most noxious to human life; and this standard might with advantage be made more stringent. Indeed, if the process of irrigation, combined with intermittent downward filtration, be properly carried out, the effluent water will flow away considerably purer than required by the standard.

Standard (*c*). The cloth works of Yorkshire turn rivers blue; the tin mines of Cornwall turn them red; coal-washings in coal-bearing districts turn them black; and the china clay works of Cornwall turn them a milky white. Most of these waters would sufficiently cleanse themselves by precipitation alone; and no great inconvenience would be caused to the manufacturing and mining interests by this standard. The chief injury caused by this kind of pollution is to cattle and vegetation. The slime spreads over river-side pastures, destroying the roots of the grass, and sometimes killing the cattle.

Standard (*d*). The salts of calcium, magnesium, potassium, and sodium occur naturally in water, therefore they are excepted. Moreover some of them, such as salt of calcium, or salt of sodium, which is common salt, are used in many processes of purifi-

cation. The risk of danger from excess of these metals is so slight, that it is but fair to make these exceptions, which enable the manufacturer to adopt an easy mode of purifying his refuse. The other metallic substances which come under this clause are poisonous or injurious metals, which enter the water by the process of manufacture.

Standard (*e*). Arsenic is considerably used in some manufactures—for instance, in calico-printing and dye-works, also in the manufacture of glass and shot; and great danger may arise from its being indiscriminately thrown into the river. Dr. Lyon Playfair gives an instance which came under his own notice at Stockport, where arsenic was discovered actually in the reservoirs which supplied the town with drinking water. The Commissioners recommend that colliery-waters and mine-water generally should be exempt from the operation of this and the preceding standard. These pollutions are not as a rule, in the cases exempted, the result of waste products of a manufacturing operation. They are the result of the natural washing, for the most part unavoidable, of natural mineral substances. The pollution which would thus be permitted is neither excessive nor of frequent occurrence. But with regard to mines where white arsenic is manufactured, they think it is only reasonable 'that some special supervision should be exercised.' They instance the Devon Great Consols Copper Mine, and say: 'It is a startling reflection, that even at the lower rate of sale, there leaves this single mine every month an

amount of white arsenic competent to destroy the lives of more than 500,000,000 of human beings.'[1] They add, that they 'are driven to this special recommendation in the case of mines where arsenic is manufactured, because it is impossible to prevent altogether the occurrence of the poison in the effluent water of such mines; and there is no practicable method of removing it from water once contaminated, so as to bring the proportion below that prescribed by our Standard (*e*).'

Standard (*f*) is directed chiefly against the waste of free chlorine at bleach-works. It is of itself valuable, and may easily be got out of the refuse water. When the amount is small, rather than save it the manufacturer lets it pass into the river, where it is very fatal to fish, and also has a tendency to prevent vegetation. It is asserted by some that the admixture of free chlorine in small quantities with sewage is a decided advantage; but, though it may ameliorate, it cannot purify foul water.

Standard (*g*) is directed chiefly against nuisances arising from alkali works. One of the refuse products of this manufacture is a combination of lime and sulphur, which, on exposure to the air, gives out sulphuretted hydrogen, smelling like rotten eggs; and it is an intolerable nuisance. Drainage-water coming from this alkali waste is a most pernicious source of pollution to rivers. The

[1] Fifth Report, p. 17.

Sankey brook is described as receiving the reekage from huge heaps of waste, and as, in fact, a sewer containing sulphur running down considerably more yellow than amber. About 20 per cent. of the mud of this brook consists of sulphur. This may easily be prevented, and the sulphur recovered at a profit to the manufacturer. Dr. Frankland estimates that, at a cost of from 40*s.* to 60*s.*, sulphur to the value of 5*l.* or 6*l.* might be extracted from this waste; and that where old alkali waste has accumulated for generations, as at Messrs. Tennant's works at Glasgow, it is found to be profitable to extract the sulphur from the drainage of this waste.

Standard (*i*) also refers chiefly to alkali works, and has been greatly opposed through an erroneous opinion that it is impossible to use all the muriatic acid produced. But if the diluted acid which cannot be used up were made to run over chalk or limestone on its way to the river, it would be converted into chloride of calcium, which, according to Standard (*d*), is admissible into streams. Alkali works cannot be carried on without using great quantities of chalk or limestone, and only a small quantity in addition would be needed. It is true it would have to be renewed as the acid dissolved or carried it away; but this would cause no great impediment. However, by this means the acid would be wasted. It happens, curiously enough, that this weak muriatic acid is the very substance required to prevent the pollution against which Standard (*g*) is directed relating to sulphur. It

ought therefore to be utilised by the manufacturer; and thus two great sources of pollution by alkali works would be got rid of at once.

Compliance with this standard would also put a stop to the pollution by iron and steel wire, tinplate, and galvanising works. This pollution is described by the Commissioners as 'intense, noxious, and notorious.' Birmingham is a great offender in this respect.

Standard (*i*) refers to an evil which it is very easy to remedy, but the mischief caused is not very great; for water usually contains a considerable amount of lime, and the caustic soda which is added neutralises the carbonic acid. Nevertheless, the evil is a nuisance and a waste, and as such should be avoided.

Standard (*k*) is intended to put a stop to one of the worst and most offensive of pollutions; and the evil, if not arrested as suggested below, is one of the most difficult to grapple with. It is caused by tar distilleries and paraffin works. The real polluting part of the refuse water can be all disposed of upon the works themselves with a little care and arrangement. Many furnaces are employed in these works; and if the polluted water be thrown into the ashpits under the furnaces, it will be evaporated by the waste heat, and so need not go near the stream. This hydrocarbon oil can never be detached from water which it has once fouled, either by filtration or irrigation. It must therefore be excluded altogether from rivers. It is so abominable, both in smell and taste, that cattle will not drink water so polluted.

If the film rests upon a meadow after a flood, the vegetation will be entirely destroyed; and no beast will touch grass over which this water has passed. It is therefore fortunate that it can be destroyed on the premises where it is produced.

The Commissioners submitted these tests to chemists of eminence both at home and abroad, and opinions were received from Baron von Liebig of Munich, M. Dumas of the French Institute, Dr. Hofman of Berlin, and many English chemists, who all agreed that the standards are perfectly practicable, erring only in not being sufficiently stringent. They took into consideration what would be fairly possible in the way of purification, and sufficient at the same time to protect rivers from the excessive pollution to which they are now subjected. It was moreover stated by Dr. Lyon Playfair in his evidence before a Select Committee of the House of Lords, 'that there is not one of these tests that is not used by manufacturers in different parts of the country and used sufficiently.'

It is true that difficulties might arise in some large towns, where land is valuable, in getting ground for subsidence-reservoirs, and filtering-beds required to carry out the provisions of some of these standards; and this might sometimes involve pumping the liquid to a distance for purification, in cases where from its nature it would be inadmissible into the sewers. But there are few towns where the comparatively small extent of ground required for this purpose could not be obtained; and facilities should be

afforded by the Legislature for the acquirement of such land. The refuse from some manufactures is, however, of a highly fertilising nature, and then it would be advisable to allow it to be discharged into the town sewers. The liquid refuse from alcohol distilleries, for instance, is a most useful manure.

We hope the exertions and investigations of the Commissioners have proved that these standards are not inapplicable. Manufacturers should bear in mind that, because they are allowed certain liberties with water for their own profit, this does not give them the right to disregard the welfare and necessities of those living lower down on the banks of the stream, and who have an equal right to the use of its waters. In giving his judgment on the celebrated Esk pollution case, the Lord Justice-General of Scotland gave expression to the following sentiments, which must commend themselves to all who are not blinded by self-interest:—'There could be no doubt that water had been sent for the use of man; and although he was to use it, he was not to abuse it; and he considered it only right that man, when using water, should again return it to the river in as pure and wholesome a state as when he took it; so that his brother and neighbour below him might enjoy the same benefits by getting the water sent him in as pure a state as he got it.'

In the Rivers Pollution Bill (1875), which has been withdrawn, no reference was made to standards of any sort. It is probable that at some future time

another Bill on the same subject will be introduced; and it is to be hoped, in the interest of manufacturers as well as of the community generally, that these or some other standards will meet the approval of the Legislature.

CHAPTER IV.

SUPPLY AND STORAGE OF WATER.

WATER in its absolute purity is unknown in nature, but a sufficient and wholesome supply ought to be within the reach of everyone. Unhappily this is not the case; and though it would appear at first sight that hamlets and villages must have a great advantage over towns in this respect, yet upon investigation it is found that they have frequently to contend, not only with scarcity, but also bad quality. Towns by co-operation can, and generally do, obtain for themselves a fairly good and plentiful supply; but in villages, hitherto at least, the means adopted by towns have been neglected, and the inhabitants have generally depended either upon the natural resources of the neighbourhood in the shape of springs, wells, and watercourses, although in some instances, comparatively few, a public-spirited proprietor has supplied the want where want has been felt. Now it is very pleasant to fancy each cottage with its own well, and each village with its own pump; but ignorance and carelessness have so fouled these natural sources of supply, that they have become dangerous to health

in a great number of cases. It is estimated that 75 per cent. of wells in villages are more or less contaminated with sewage. Out of 429 samples from different wells, it was found that 307 were unfit for drinking purposes. These wells are for the most part what are called surface wells, at a very little depth below the level of the ground, and the water in them is frequently the drainage of the adjacent privy, merely clarified by passing through a stratum of soil of greater or less thickness, and mixed with rain-water that has also soaked through. This slight filtration may possibly remove any unpleasantness in smell or taste; but nothing is more delusive than to suppose that because water is bright and sparkling, it must necessarily be pure and wholesome. The Rivers Pollution Commissioners, when at Rochdale, found that place plentifully supplied from a distance with first-class water, soft and free from animal impurity; but a spring near the churchyard was preferred for drinking by many of the inhabitants, though strongly impregnated with the inorganic remains of decayed organic matter. It exhibited a previous animal contamination of no less than 17,818 parts in 100.000, derived almost certainly from the drainage of the neighbouring burial-ground.[1] Perhaps the worst instance reported by the Commissioners is the village of Leyland, which they say is a fair type of many others they visited. It is situated on a

[1] Rivers Pollution Commission, First Report, vol. ii. Minutes of Evidence, pt. 3, Q. 681.

sandy, porous soil, through which the liquid contents of the cesspools and privies rapidly soak into the adjoining shallow wells. The analysis of a sample of water drawn from a well, situated only a few yards from two privies, contained no less than 24,360 parts of previous sewage, or animal contamination, in 100,000. The water in these wells consists, in fact, chiefly of house-slops and liquid human excrements, diluted to some extent with rain-water. The drinking water of Leyland was little better than filtered London sewage.

How to supply such villages, where the inhabitants are few, with pure water, is a problem of great difficulty; yet it must be solved if we are to avoid the scourges of fever and disease described in our opening chapter. In summer time the little liquid contained in these shallow wells becomes still more charged with impurities, and frequently they dry up altogether, leaving the inhabitants to supply their wants at stagnant ditches and ponds, receiving the drainage of farmyards and the droppings of cattle. In very dry seasons even these may fail, and then the cottager has to fetch water from a great distance, or purchase it for 1*d.* or 2*d.* a pailful, which at the lower rate would be two guineas for 1,000 gallons. This is worthy of note, for it is by no means an unfrequent occurrence in country districts, and must be a sore tax upon the wages of a labouring family. If some simple source of supply of wholesome water can be found, even at a small weekly cost, there can be no doubt it would

be the greatest boon, and would be eagerly welcomed. What then can we recommend? Surface wells must be condemned, except in very rare cases, where they are at a distance from any possible chance of contamination. The only natural sources of supply which remain are springs and watercourses.

Springs are of two kinds, intermittent and perennial. Intermittent springs burst forth generally at the end of the rainy season of winter, but during the droughts of summer they usually fail. Perennial springs are supplied from the subterranean water-bed; and unless this has sunk below its usual lowest level, as is sometimes the case in very dry seasons, they give a constant supply. It is from these that rivers and streams chiefly derive their water, supplemented by what runs off the surface of the ground during rain, and drains through the land naturally or by artificial means. The supply from these two sources is rarely sufficient for the household purposes of the community even in small villages, though the water from perennial springs is more abundant, and in most cases of an excellent quality for drinking.

When running streams pass within a convenient distance, and are uncontaminated, they form a very valuable source of supply. The water is obtained from them by dipping, or by pumps placed on the banks; but great care must be taken to prevent defilement from surface drainage. It must be confessed with regret, however, that rivers and streams are seldom pure enough to be used for

drinking water. Near their source they are wholesome, but, as they flow onwards, they receive the refuse and sewage of the towns, factories, and villages on their banks; and even when it shall have come to pass that solid matters are forbidden, and effluent liquids are to some extent purified, it will not be advisable ever to use river-water for drinking. It may be good enough for ordinary cleansing purposes, but it ought to be laid down as an axiom, that water which has once been mixed with sewage, even in its comparatively purified state, is never safe for human consumption. We see, then, that it is only a few country districts and villages very favourably situated that can depend for their supplies upon the water that nature places at their doors. Others must be at some cost and trouble to supply themselves with this important necessary, if health and life are to be preserved.

We are not without hopes that in the course of time a general system of water-supply for all places within the bounds of each [1] watershed-basin may be established. Every large river has contributory streams and brooks flowing down the various valleys within its basin; aud we believe it will be perfectly possible to form large reservoirs at the head of each valley for the constant supply of the towns, villages,

[1] The watershed is a range of high land that casts the water in different directions. If, then, an imaginary line be drawn, marking the ridges from which the water flows to supply a certain river and its tributaries, this line will form the boundary of the catchment-basin of that river; but instead of the term 'catchment-basin' we prefer that of 'watershed-basin' or 'area.'

factories, and even separate houses within its bounds; and that this may be done without interfering with the rights of riparian proprietors, or the requirements of manufacturers; and also without damaging the stream, but rather the contrary. The water, being thus stored at the various spring-heads, would always be pure and uncontaminated. This scheme, however, is too vast to be discussed in these pages; and years must pass before it could be brought into action. We content ourselves therefore in this place with merely pointing out what we believe will be the ultimate solution of the difficulty of water-supply, and will afford grand scope for the genius of civil engineers. At present, let us discuss what is immediately practicable, and at the same time simple and inexpensive, remarking that the scheme which best complies with these conditions will not be the same for every place. We will indicate the various means which exist for obtaining water, and each locality must adopt that which is most suited to its own circumstances.

In all country districts, except those under the favourable conditions mentioned above, it will be necessary to store a supply; and in discussing storage, the first thing to be determined is the average quantity sufficient for each person. In ancient Rome, so celebrated for her aqueducts, the allowance was 340 gallons a head in the day. In New York at the present day each citizen may have 300 gallons. This amount is far greater than is necessary. Indeed, it cannot be expended without enormous waste.

Sixty gallons for each person in the day would be ample in the largest towns under all circumstances. The London waterworks supply each person with only 33 gallons.[1] At Paris the allowance is 30 gallons; but as soon as the new reservoirs are ready, this will be increased to 45 gallons.[1] Our rural population, we are very sorry to say, are not much given to wash either themselves or their houses. Let us hope, when their surroundings are made more comfortable and wholesome, and a supply of pure water is ready for their use, that they may gradually learn to take more delight in personal cleanliness. It is estimated that, on an average, the consumption of water in cottages does not exceed two gallons each in the day. If therefore we allow from 10 to 25 gallons a head, according to circumstances, we shall have made a great advance. In making this estimate we are supposing earth-closets to be in use, or that the flushing of the village water-closets is under the separate management of the sanitary authority, except in private houses; otherwise the allowance will be insufficient.

Let us consider now the best means of procuring and storing a sufficient supply of water. It may be possible in some places to divert a portion of a stream running at a higher level, and bring the water by means of a conduit or water-pipes to a reservoir at the highest part of the village; and then by distribution-pipes give a constant supply to every

[1] Since the above was written the new reservoirs have been completed.

house and cottage. There will often be great difficulties to be overcome even when such a course is practicable. The stream from which it is proposed to draw the supply may pass through the lands of owners who are unwilling, even for any compensation, to surrender a portion of their water rights. Sometimes, however, where the higher level belongs to the same landowner as the village, this difficulty might not arise, and the water could be supplied at comparatively little cost. The reservoir, with supply-pipes for an average-sized village, might probably be constructed for 400*l.* or 500*l.*, including the cost of land. In thirty years both principal and interest could be repaid by a rate of 2*d.* per week upon cottages under a certain rental, other houses being charged according to their ratable value. Village reservoirs such as we are describing would necessarily be small, and ought therefore to be covered in, because the influence of the atmosphere is greatly conducive to organic life. If uncovered they ought not to be less than 15 feet deep, to prevent vegetation.

The underground water-bed must not be omitted from our consideration. It will provide an abundant supply for villages and houses situated on the old and new red sandstone, on the green sand formation and on chalk. The water must be obtained by deep boring, and the depth at which it will be found will vary very much according to the geological formation. The most economical motive power for pumping it up is wind, with a provision for employing supplementary horse-power occasionally. The water can

thus be raised to any height required, and thence conducted over the village by gravitation. It is essential that only a small supply, sufficient for two or three days' consumption, should be stored above ground; because deep well-water, when exposed to the atmosphere, rapidly absorbs impurities; and it has also a peculiar affinity for the metal-piping through which it must pass in the process of pumping. A small reservoir only will be required therefore; but it is more important than in other cases that it should be carefully roofed over. The great drawback about this water is, that it is generally very hard; and, though pleasant to drink, it is not very good for washing or cooking.

Rain-water, if properly stored during the rainfall, would afford a sufficient supply for the whole year. The average rainfall for England and Wales is about 32 inches in the year. We shall understand this better, if we state that an inch of rain, falling on an acre of ground, is equivalent to about 22,600 gallons, and in weight is about 100 tons. The total amount of rain that falls during the year may be estimated at 27,019,632 millions of gallons. Now if we allow each person 25 gallons a day, he will use 9,125 gallons in the year; and, as the population numbers about 25 millions, the amount required for a year's consumption would be about 228,125 millions of gallons. Add to this the quantity consumed by animals, which may be estimated at 91,000 millions, and the water required for steam-engines and other machinery estimated at 125,000 millions of gallons,

and we find that 1,000 millions of gallons a day, or 365,000 millions of gallons a year, will be sufficient for the wants of man and beast in England and Wales; and that is only one 74th-part of the total rainfall. We surely ought never to be obliged to complain of scarcity of water with such a marvellous provision of nature for our wants. Yet we squander and neglect to store up that which falls upon our very houses. The only requisite is storage-room. Now, if an ordinary cottage roof measures $2\frac{1}{2}$ poles, and we take the annual rainfall at only 20 inches, this roof alone will collect 7,000 gallons, if it is properly fitted with rain-troughs under the eaves, and down-pipes. Sir Philip Rose, in a letter to the 'Times' in 1873, described a plan in use upon the chalk of the Chiltern Hundreds. He said that a tank ten feet deep and six feet square, sufficient for two ordinary-sized labourer's families (if the troughs from the cottage roofs are properly connected), can be made in that district, at outside cost of 2*l.* per cottage. There the ground is simply excavated and plastered with three coats of Portland cement mixed with sand and gravel. But the expense will of course vary with the nature of the subsoil. In no case, however, can it be very formidable.[1] A tank 16 feet long by 10 feet wide will, for every foot of depth, hold 1,000 gallons. Where this plan is adopted it would be advisable that the water, as discharged into

[1] See a paper read before the Farmers' Club, by Mr. James Howard, of Bedford, in November 1874.

the tanks from the roof-pipes, should pass through a fine wire gauze strainer, so that any extraneous substance may be prevented entering the tank and decomposing in the water. This strainer should be removed and cleansed after any considerable rain-fall by the officers of the sanitary authority. In larger houses, with a greater surface of roofing, larger tanks would of course be necessary. From a house whose roof covered 10 poles, 28,000 gallons a year might be collected. In addition to the gauze strainer, a filter of some kind exposed to the air may be recommended for large tanks, through which the water should pass as it is drawn off for consumption. The roofs of the parish church and of the schools would collect a considerable amount, which might be stored as a public supply. Even where there is a sufficiency of good water from other sources, we would recommend the storing of rain-water in the larger houses. It is always soft and pleasant; and for watering gardens it is the very best next to the rain as it falls. Great care must be taken that the tanks are water-tight, so that no sewage or ground surface water can find its way into them. The use of open tubs for the collection of rain-water is much to be condemned. They are seldom cleaned out, and frequently contain water that is putrid and unwholesome to the last degree; but, until a better means of supply is established under the supervision of the sanitary authority, it would be unwise to forbid them entirely; whilst for drinking or cooking purposes their use ought to be strongly discouraged.

There is another source of supply, and another method of storing water, which some persons have strongly advocated. It is exceedingly simple, and would be practicable in nearly every country district. We refer to the water that now runs into the rivers from the underdrainage of land.

In order to make the advantages of this method apparent, we must make a brief digression to explain the process of underdraining, to which we have had occasion to allude in former chapters. It is pretty generally known that at some depth below the surface of the ground there is a permanent water-bed situated in what are called the water-bearing strata. When rain falls on the earth, it either passes off the surface as storm-waters, and goes to feed the rivers and watercourses, or it penetrates the soil, where some of it is assimilated by vegetation, some of it is evaporated, and the rest is held in the earth by the force of capillary attraction. But when, as in winter, vegetation is dormant, and there is little evaporation, and at the same time much rain falls, the soil becomes so soaked that it can hold no more, and the superabundant water then descends to the underground water-bed, causing the level of this bed to rise. As it rises, first the lower, and then, in turn, the higher intermittent springs, which have been dry since the preceding season, begin to run, and the ground being still saturated, if heavy rain continues, floods will ensue, because the ground with its water-bed can hold no more. In due course, as spring advances, the running of

the springs, the renewed action of vegetation, and the increase of evaporation with returning warmth, cause the water-level to sink. First, the higher springs become dry, the others follow, and the water-bed reaches its lowest level. Now the object of underdrainage is to prevent the underground water from rising above a certain level. Drainage-pipes are laid at the desired depth below the surface, say from 3 to 8 feet, varying according to the nature of the soil to be drained. Until the underground water reaches these in its upward course, they are idle, just as the intermittent springs; but as soon as they are reached, they begin to discharge freely, and if the land be properly drained the water cannot rise above them. By this means the soil between the drainage-pipes and the surface of the ground can never for long be super-saturated, for directly it becomes so the surplus water descends to the water-level, which is never higher than the drain-pipes. Now it is obvious that any intermittent springs which existed previously to the land being drained, if above the level of the drain-pipes, will now run no longer; but this is no loss, as might at first be supposed, for we have, instead of the intermittent springs, the discharge from the outlets of the drain-pipes, and this water it is which it is proposed to utilise for country supplies. We here profess to treat of underdrainage simply as it affects water-supply, and do not stay to discuss the advantages from an agricultural point of view, or to combat the hostile and ignorant opinions which are

sometimes expressed against land drainage. Let us, however, pause to point out, as we have already done,[1] the benefits to health which arise from a dry and well-ventilated soil. Experience has proved that underdraining has a great effect in diminishing lung diseases, more particularly consumption. We have then a threefold benefit—a benefit to agriculture, and a benefit to public health in two ways, in the diminution of disease and a new supply of water. Very little engineering skill will be required to store this supply in a suitable reservoir such as we have described at page 81. If the outlets of the land drains are at too low a level, it may sometimes be necessary to raise the water by wind power to a second reservoir at the required height. The quality of this water will be nearly the same as that of the underground water-bed, unless, indeed, it has passed in its ascent through clays possessing medicinal or other properties. This is not often to be expected, and by a careful analysis of the water from the intermittent springs, any danger may be avoided. No sewage must be allowed to undergo purification on the land from which the water-supply is obtained by underdrainage. Difficulty will seldom be caused by this proviso, because, whilst water would generally be gathered from the higher ground, the sewage would, on the principles of gravitation, be discharged below the village. This method of storing water might be used with advantage by farmers on dif-

[1] See p. 19.

ferent parts of their holdings for the supply of their cattle, and for the engines used in cultivation.

One other possible source of supply occurs to us, in case the main-pipes or conduits of large town waterworks pass through or near country villages. By agreement with the proprietors of the waterworks, the village reservoir might be kept continuously filled. We are inclined to the opinion that this method might frequently be found practicable.

The dew-ponds which are to be found on the chalk downs in the South of England are alluded to by most writers on water-supply; but they would not be available for any large demand, though very useful for sheep and cattle. They are interesting as curiosities in natural philosophy. White accounts for them in his History of Selborne, by saying that 'water by its coolness is able to assimilate to itself a large quantity of moisture nightly by condensation.'[1] It has been ascertained that they are not fed by springs.

Before leaving the subject of water, we wish to make a few remarks on the supply of water to water-closets, which in the better class of houses are within the house. For flushing, a service cistern is or ought to be provided above the closet, and devoted solely to that purpose. It is worse than useless to trust to the house-slops for flushing closets. No means of access should be possible by which servants or others

[1] Letter 71.

can employ the water in this cistern for any other purpose. We have known instances of houses built in the present day where the same cistern is made to do duty for the water-closet and for the general supplies of the house, cooking and drinking included. It is hardly possible to conceive anything more calculated to lead to bad health, and perhaps cause fatal disease. Every time the closet is flushed, the foul air which has accumulated in the supply pipe rushes up into the cistern and contaminates the water. If there is a waste-pipe to the cistern, it must not run into a drain, but discharge itself over a gulley, as described at page 23. The house supply of water must be kept entirely separate.

But water-closets are sometimes not provided with any service cistern at all. A tap and supply-pipe bringing water directly from the main is used for flushing the soil-pan. The results from this filthy plan have been so horrible, that it might with advantage be made illegal. People leave the tap open and the water running, either from carelessness or to give a more complete flushing, forgetting to return and turn off the water. Whenever the mains become empty, either from the supply being intermittent or from repairs being executed, a vacuum is created, and not only foul air, but water-closet soil, has been sucked up into the main, and the whole water of the district has been contaminated. Dr. Thorne, of the Local Government Board, discovered that this had been a frequent occurrence at Lewes,

which on more than one occasion has suffered most severely from typhoid fever; and the bad water-closet system contributed greatly to the spread of the disease.

The attention of the Legislature might well be directed to village water-supply. In our next chapter we shall point out a few practicable improvements, which would greatly aid local authorities in their endeavours to provide sufficient and wholesome water.

CHAPTER V.

SANITARY LEGISLATION AND ADMINISTRATION.

ENGLISH legislation on social matters is for the most part tentative, and rightly so. It is always dangerous to deal with the social arrangements and customs of a people in an arbitrary manner. Well-informed men of science and eager philanthropists may urge definite reforms upon a Government, and Government itself may see clearly that what is urged would be for the real and ultimate interest of the people; but unfortunately the majority are given to consult their immediate and apparent interest only. A representative Government cannot compel people against their will in these matters. If the attempt is made a feeling of hostility is aroused, and the desired ends will be defeated, or at least delayed. It is not sufficient that a Minister should have a well-digested mass of information before him on social subjects requiring reform; he must also feel assured that the country will accept his legislation in a willing spirit. It is hard to convince those who like to be dirty that it would be much more pleasant to themselves and others to be clean, and though it is quite possible to bring water to the animal, it is

impossible to force him to use it. In the debates on the Public Health Act, 1875, it appeared that several hon. members were of opinion that the people of this country are not prepared to advance in the direction of sanitary improvement with those rapid strides that scientific sanitarians think absolutely necessary. This is very lamentable, but we fear it is true; and until the majority of persons are willing to submit to it, compulsory legislation, if made more stringent than at present, would be quite inoperative. Our present system of local self-government, which is healthy and sound in principle, though occasionally needing reform and adaptation to the requirements of the age, is pre-eminently characteristic of a free people. From the earliest times of civilisation it has been the custom of this country, and any attempt to disturb it in favour of absolute centralisation would be most unwise. Nevertheless, we may acknowledge that it has its drawbacks; and one of the chief of these is, that the administration of a compulsory Act generally disapproved of would rest with the representatives of those who disapproved of it, and who possibly might be themselves interested in keeping up the abuses against which it was directed. The popular dislike to it would also react upon the legislators themselves; and as a reward for legislating for the good of their countrymen, they would probably lose their seats in Parliament at the next election, without the satisfaction of feeling that they had succeeded in doing any good, or that their services had been appreciated. In fact,

they would have committed a legislative blunder. The great problem in social legislation which a statesman has to solve is, how to make the people, or rather the majority of them, see what is for their own good, and induce them to submit to certain regulations for their own ultimate interest; and tentative legislation is framed to educate public opinion, and so provide stepping-stones on the road to reform. As experience of them will show how beneficial certain permissive measures are to the general good, opposition will decrease, and the laws may then be codified in a compulsory form. Legislation of this kind must not be too far in advance of public opinion; but neither ought it to lag behind. The mind of a statesman should be able to grasp at once the various indications showing that public opinion is ripe for more stringent measures, even before the public themselves are fully aware of the advance they have made.

The Public Health Act, 1875, as we understand it, is not an Act to confirm and perpetuate the existing sanitary laws. Mr. Sclater-Booth, the President of the Local Government Board, did not propose to codify permanently, but to consolidate, and bring within a glance, the confused mass of enactments which had become law during the last twenty-eight years; and so afforded an opportunity for reconsidering the whole question after these years of varied experience, during which knowledge has been growing fast, and definite opinions have been formed. Thus the ground has been cleared for future legisla-

tion. We cannot help thinking that it was most wise and judicious to bring this consolidation forward in the shape of a Bill before Parliament. By this means public attention is attracted; and, the law being placed before the country in an intelligible shape, free discussion may take place, and many valuable and practical suggestions may be developed. Had the Government contented themselves with consolidating the existing laws for their own information merely, and as a foundation for an immediate enactment of a permanent character, all these advantages would have been lost; and it is not improbable that such a measure would ere long have required amendments and additions, so that we should again have been involved in the bewilderments of confusion. Taking this view, we cordially welcome the Public Health Act; and we believe that so much hostile criticism would not have been launched against it if Mr. Sclater-Booth's speeches had been attentively read and impartially considered. By these only can his aims be properly understood. But the critics appear to have ignored the proceedings in Parliament, and to have taken the Bill as a permanent measure, and so have fallen foul of it.

The diversities of opinion amongst men of science, and even amongst the advisers themselves of the Local Government Board, cripple the action of a Government, and present great obstacles to permanent legislation of a compulsory nature. Would it be wise or expedient for a Government to propose compulsion, when its own experts are in doubt as to the

extent of the evil, and as to the proper course to be pursued; and, even when these are agreed among themselves, if their opinions do not command the confidence of independent men of science and acknowledged ability? The opinions about the pollution of water by sewage are most contradictory; some authorities asserting that water so contaminated, even after the sewage has been purified, is never safe for human consumption; others contending that, after oxidation, it is harmless. The conclusions of Dr. Frankland, who may be considered one of the most enlightened chemists of the day, both practically and theoretically, have been much disputed; as also were those of Professor Way, his predecessor on the Rivers Pollution Commission. People who are averse to any sanitary legislation are only too ready to seize upon these differences of opinion, as reasons for not attempting any improvement. The study of physiology and practical chemistry have been too much neglected, and it is a reproach to scientific men that chemical questions should be such matters of dispute; yet it is notorious that experts, who are called upon for evidence on the same subject, will frequently give opinions diametrically opposed to each other; and this is the case both with regard to chemistry and civil engineering. A Minister has no easy task before him when he has these obstacles to contend with. He is expected not only to discriminate between opposing opinions, but also to be able to steer clear of the crotchets of medical and engineering enthusiasts, and yet to see what is really

practicable. It should be the object of all sanitary reformers to spread abroad useful information, and to strive to convince the public mind by practical demonstration of the desirability of improvements in their domestic arrangements and habits; and to prove to manufacturers and others the feasibility of the various processes of purification which are recommended to their notice. In pursuance of this object, we shall attempt to point out briefly a few amendments to the existing law which appear to us to be necessary to prevent disease and secure a high condition of health, without too great interference with the domestic habits and comforts of the people; and we shall also suggest the exercise of certain powers by the central Government and by local sanitary authorities, in order that the laws may be more efficiently administered.

We are glad to notice that the Public Health Act, 1875, introduces several amendments of great importance, about which it was advisable that there should be no delay; and we are inclined to the opinion that a few others might have been proposed without any great opposition. Such, for instance, as the following:—In the first place, it would appear desirable that the powers of urban authorities to make bye-laws should be extended to rural authorities. There seems to be no adequate reason for the difference now existing. Rural authorities could then issue building regulations, and would have some control over the condition of dwellings. They could regulate such matters as interior space and ventila-

tion, and insist on the due construction of privies, ashpits, and private sewers, in connection with the village system of sewerage. We would suggest that, as an aid and guide to local authorities, the Local Government Board should draw up a code of building regulations of general applicability, treating of these matters and others that we have discussed; with liberty for each local authority to modify these to suit its own peculiar circumstances, subject always to the approval of the central authority. All who wish to provide decent and comfortable dwellings would welcome such a code, as it would assist them to carry out their desires. The speculative builder alone would be likely to be affected by the stringency of the regulations, and that would be a decided gain to the health and comfort of the occupiers and the public generally.

The Local Government Board should have the power to grant permission to rural authorities to erect cottages under a fixed rental, where, on careful inquiry, it is ascertained that such improvements are urgently needed. The local authority would then be better able to exercise their powers to prevent overcrowding.

More powers are required in the matter of water-supply. It not unfrequently happens that part of a parish may be supplied with water, whilst some houses are without any. It is most unfair to tax the whole parish for the benefit of these houses. Either there ought to be power to compel the owner to provide a sufficient supply; or, as it is now proposed in

certain cases to exceed the limit of two-pence a week by special permission from the central authority, the cost might be charged as a private improvement, there being no reason that we can see why private improvement works should not be undertaken for a number of houses in common. The principle of private improvement expenses requires to be set forth more distinctly by Act of Parliament. If works essential for the health and comfort of inhabitants were more generally chargeable as private improvements, the effect would be to throw the cost upon the owners instead of upon the rates, and so local taxation would in some degree be less liable to increase. It may happen that sometimes there are several owners of dwellings in a village, and that the neighbouring landowner is able and willing to supply water, if he might be allowed to charge his estate with the expense. As the law now stands, he may only charge his estate with the cost of providing water to his own tenants. It would be a real boon to many villages, and often a simplification of the water-supply question, if the provisions of the Lands Improvement Acts were extended in such cases. A sufficient village water-supply might often be collected on many estates, and the objections of many landowners to provide it would be removed if they were granted this privilege. A standard of purity for drinking water should be established by Government, and the water should be tested at intervals under the direction of the Government Analyst, so as to ascertain whether its quality is properly maintained.

By far the most important amendment we have to suggest is the registration of diseases. Unless this is made compulsory, we believe it will never be possible to check the frequent outbreaks of severe epidemic. All medical practitioners, whether in private or official practice, ought to be compelled by law to report immediately to the medical officer of health any cases which they may be called upon to treat, of cholera, epidemic, endemic, infectious, contagious, and all zymotic diseases. A fever may smoulder quietly in a place, cases occurring here and there, no notice being taken, until at length a general epidemic and panic occurs; whereas, if the medical officer of health were promptly informed of the first case, it may fairly be expected that he would be able to get on the trail of the disease, and trace it to its origin. A most strict system of registration should be established, and the medical officer of health should not only forward a periodical report to the Local Government Board, but should make special reports as occasion requires. And this brings us to point out a power which we should greatly like to see exercised by the Local Government Board. We mean, that on the first intimation from the public health officer of a district, the central authority, instead of remaining inactive till a considerable number of deaths have occurred, should at once take active steps to look into the matter. A single case of preventable disease should be considered *primâ facie* evidence of neglect

somewhere; and the origin of the disease may be easier traced at the beginning of an outbreak than by waiting till the mischief is confirmed. Mr. Simon, as seen by his last annual report, is strongly of opinion that the Central Government should have the superintendence of results; that there ought to be a systematic vigilance to discover whether local authorities are doing their utmost to prevent disease, and that they should have power to intervene before intervention is too late. So much we think might safely be granted without too great an interference with the principle of local self-government.

Facilities ought to be afforded whereby local authorities may acquire land without delay for the purposes of disposing of their sewage and refuse, and for establishing waterworks. Easements also are necessary for the construction of culverts, and outfalls for drainage, and the laying of water-pipes. It happens sometimes that an inspector holds inquiries, consuming time and money, and often resulting in the condemnation of the sites and schemes successively laid before him, and the sanitary authority are thus unable to deal with the evil with that promptness which is necessary to success. A very practical suggestion has been made by the Slough sanitary authority, that 'the inquiry of an inspector should be directed, not so much to the intrinsic merits of any particular given site or scheme, as to the relative or comparative merits of all the sites or schemes available for the district requiring attention; and therefore that all avail-

able sites and schemes should be brought under his notice and deliberation before he shall be required to decide upon any one of them.'

In making these suggestions we have endeavoured to avoid anything like undue interference with Local Government, or the privacy and habits of families. We believe they are likely to meet with general approbation, and yet are such as will be really beneficial towards protecting and improving the public health.

Legislation upon the pollution of rivers requires great caution. Immense interests are involved; and whilst providing as far as possible for the greater purity and usefulness of streams, the Legislature has to be careful not to inflict injury or entail unreasonable expense upon manufacturing and mining industries of national importance. We believe that all the community, without exception, will unanimously welcome any law which absolutely forbids, under adequate penalties, the casting solid matters into river channels, allowing no loophole for evasion. With regard to liquid refuse, two cases require attention—that of the sanitary authority, who have to dispose of sewage, and that of manufacturers and miners, who have to get rid of an immense amount of foul and poisonous liquids, the refuse of various industrial processes. We think we have shown in a former chapter how sewage may be safely and advantageously disposed of; and there is no reason why the legislation as to solid matters, proposed in the session of 1875 in the Rivers

Pollution Bill of the Marquis of Salisbury, should be delayed. But with regard to the case of manufacturing and mining liquid refuse, there are great difficulties to be met. It was evident, whilst the Rivers Pollution Bill (1875) was under discussion, that this portion aroused great hostility amongst the mining and manufacturing interests, though erroneously, in our opinion; and we believe that the Marquis of Salisbury showed great wisdom in withdrawing those clauses, seeing that the public opinion of the classes interested was not yet sufficiently ripe for the measures proposed. The Bill itself was subsequently withdrawn, owing to the pressure of public business; but we may confidently expect that a Bill on the same subject will be introduced ere long. We hope that in the interval the manufacturers will have discovered that they are needlessly alarmed. When Lord Derby introduced his Alkali Act, there was the same outcry; but experience proved the manufacturers to be in the wrong, and they now confess that they have been greatly benefited by that legislation. So in this case we may infer that they themselves will reap the greatest benefits from the improvements they now deprecate. Let them apply themselves to the consideration of the matter in a fair and unselfish spirit, and we believe their opposition will vanish in most instances.

It was with the greatest satisfaction that we observed in the Rivers Pollution Bill the proposal to establish Watershed Boards, or, as they were called, 'Conservancy Authorities.' We have long been of

opinion that such an authority is absolutely necessary for the efficient carrying out of sanitary measures; and in course of time we hope to see these Boards occupy a very prominent position in our system of local government. The Bill provided that this authority should be constituted of the representatives of the sanitary authorities within its area of jurisdiction. We believe it would be better if the conservancy authorities were elected by and from among the members of the several County Boards[1] within the watershed area or catchment-basin of any river and its affluents. This constituency would insure members of a higher class than the average of the sanitary authorities, as at present constituted. They would be educated and independent, and able to take a broad and liberal view of questions affecting the welfare of their district. Each Board should have the power to appoint committees from their own body to preside over the basins of the various affluents of the main river. Every member of the Board should be resident within the area of the watershed-basin, and members of committees within the basin of the affluent under their jurisdiction.

Space will not allow us to do more than sketch a few of the duties which might be advantageously discharged by these authorities. They should have jurisdiction not only over rivers, but over all the sanitary authorities within the area of the river-

[1] County Boards for the administration of the various branches of local government, except justice, have not yet been established; but we believe they are not far distant.

basin. They should also superintend the main-drainage of land, the highways, and water-supply. They should have the power to remove water-mills, weirs, and other obstructions, also to group sanitary authorities together for the better working of the laws on public health; and they should act generally as an intermediate authority between such sanitary authorities and the Local Government Board. In fact, they should have the decision of all matters concerning the river-basin, subject to an appeal to, and the supervision of, the central authority. The advantages of such a Board are manifest. Unity of action, which is absolutely essential, would be secured throughout the whole watershed; and instead of small local authorities frittering away money on independent efforts, combination could be insisted on with much greater effect than if such grouping were left to the central power. A most interesting paper on the subject of Watershed Boards, by Lord Robert Montagu, is appended to the second volume of the Second Report of the Royal Sanitary Commission. Without committing ourselves to all the conclusions therein stated, we may say that its perusal will be found very instructive.

We do not propose making any change in the unit of area for the purpose of sanitary administration. The Union is perhaps the most convenient for all purposes of local government and taxation. Its organisation is complete, and it has its various officers, who on the whole perform their duties efficiently. But if watershed or conservancy autho-

rities were established, it might be necessary to alter the boundaries of some Unions so as to make them lie wholly within one watershed-basin. The simplification of areas is likely to come under the consideration of Parliament very shortly; and we believe this might be done without interfering with county business, or creating any new complication.

We should not consider our remarks complete if we did not make some suggestions upon the appointment and position of the medical officers of health and of the district surveyors. Upon these officers will greatly depend the success of all sanitary legislation. They ought to be the officers of the Watershed or Conservancy Boards, appointed by them, but not removable except by the Local Government Board. The effective capability of the district surveyor or engineer is nearly equal in importance with that of the medical officer of health. None should be appointed to the office without a diploma of proper efficiency based on technical studies. If the watershed area be very extensive, the Conservancy Board should have power, subject to the sanction of the central authority, to appoint more than one of each of these officers; but the district assigned to each must be sufficiently large to occupy his whole attention. They must never be allowed any private practice; for the jealousy of other practitioners would in such case be a serious obstacle to their powers of usefulness. A sufficient salary ought to be paid to secure the services of experienced and competent men; and as they would hold an independent

position, it is to be hoped that all medical men and surveyors in private practice in their respective districts would co-operate with them. In the case of the registration of diseases, we have already suggested that medical men should be required by law to make an immediate report. The duties of the public officer of health and of the district surveyor would be eminently of a national character; their salaries therefore should be paid out of the national funds. They should be required to be in direct correspondence with the Local Government Board.

The Poor Law medical officers should be the officers of the local sanitary authority, but subordinate to and receiving instructions from the medical officer of health, with whom they ought to be in constant communication, and working in cordial co-operation. The acquaintance of these medical officers of the local sanitary authority with the habits of the poorer classes will make them invaluable assistants.

The great bar to sanitary, and indeed to all local improvements, is the pressure of local taxation. All new charges for these purposes are thrown on the rate-payers, and are levied upon one description of property only—real property; whereas all ought in justice to contribute to local burdens in proportion to the benefits received; and in many cases real property receives less benefit than other descriptions, and yet has to bear the whole burden. The subject is too large for us in this place to do more than just allude to its bearing on the Sanitary question; but the expenses of Sanitary administration are not unlikely

to hasten the consideration of the whole subject of local finance and government, and possibly lead to a reconstruction of the present system on a broader basis of justice and equity.

After all, legislation can do but little, unless aided by the cordial co-operation of each individual of the community. A solid and lasting improvement must be based on a change of habits in the people themselves; and we must not be too sanguine that this can be brought about at once. People must be educated to feel the advantage of a change. The bad and uncleanly habits that have been indulged in for the greater part of a man's life are well-nigh incurable; but the younger generation may be taught, and on them the effort must be made. The upper and middle classes of this country are perhaps in their persons the cleanest people on the face of the earth, but their cleanliness is of very recent date. In the reign of Charles II., Pepys enters in his diary, as a curious circumstance, the fact of his wife taking a bath: '21st February, 1664. My wife busy with her woman to the hot-house to bathe herself, after her being long indoors in the dirt, so that she now pretends to a resolution of being hereafter very clean.' And he cynically adds: 'How long it will hold I can guess.' He also thinks it worthy of note when he has had his ears washed by his maid-servant, and caught cold in consequence.

The ancient Romans were pre-eminently a clean people, and they have left traces of their personal habits in every country they conquered. No Roman

house was complete without a bath. After their downfall a long reign of dirt commenced. Michelet informs us that for a thousand years there was not a bath taken in Europe. In Saxon England some of the customs the Romans had introduced lingered until the eve of the Norman conquest. We are told by the Chronicler that, even at the smallest house, the host courteously offered the bath, and the hostess linen, curious and fragrant; and Giraldus Cambrensis observes, as something very extraordinary, that the Welsh cleaned their teeth. The early Normans, too, were remarkable for their love of personal ablution, never sitting down to supper without having previously bathed, wherever it was possible. Perhaps people were dirtiest in their habits during the reigns of the Stuarts and the Georges. Since those times there has been a great revival of cleanliness; and, as education advances, we may reasonably expect that it will extend itself to the poorer classes. It would be difficult to believe that there is any innate fondness for dirt amongst these. The people once were clean, why may they not again become so?

But it must be acknowledged that there is a great deal of stolid apathy to be overcome, first to induce habits of personal cleanliness, and then to overcome the reluctance to adopt sanitary precautions of proved value; and the stolidity in the latter respect is not confined to the poorer classes. Carelessness and ignorance have so engrained certain habits amongst us from generation to generation, that to break through them is like acquiring a second nature.

There are many who have leisure and experience, and who take, or profess to take, an interest in sanitary matters. Let them become members of sanitary boards, and devote some portion of their time to help in the efficient administration of sanitary laws. As long as these hold aloof it is almost hopeless to expect any satisfactory results. We would also suggest that at every school under Government inspection, whether for boys or girls, at least one hour in the week should be devoted to a lesson on the commonest and most every-day matters connected with cleanliness and health; and let cleanliness of person be insisted on with the utmost strictness. Where the water-supply is good, village baths and wash-houses might be erected; and they would have a good effect in encouraging cleanly habits. At present we must allow that the labourer cannot derive much encouragement to be clean and tidy from the state of his dwelling and its surroundings, for the means of being so are almost beyond his reach.

Voluntary efforts may also do a great deal in removing the difficulties in the path of reform, by teaching people how to acquire habits of thrift and cleanliness. The success of recent lectures on domestic cookery has shown that people will come to listen; and we can conceive of nothing likely to have a better effect than cottage lectures on matters of domestic economy by ladies, addressed to women and grown-up girls. The philanthropist may also take pleasure in encouraging the cultivation of

cottage gardens. Let habits of cleanliness, thrift, and economy once be acquired, and the pleasure resulting therefrom tested, and there is fair ground for hoping that they may become permanently engrafted on the character of the people.

We have had no space to discuss the subject of village hospitals in affiliation with the County Hospital; but before long we hope to see one of these in every district. In cases of infectious or contagious disease they would be most valuable aids to prevent the spreading of the epidemic. Decent mortuaries ought also to be established for the reception of the dead until burial.

From a pecuniary point of view alone we believe that, even where sanitary works are not directly remunerative, experience will show that a great saving is effected. There will be an increase of labour power, a decrease of pauperism, and less money to be paid for relief and medicine on account of preventable sickness. When provided with pure air, pure water, good food, and wholesome surroundings, the physique of the people will improve, the average term of life will be longer, life itself will be more enjoyable, because a higher condition of health has been attained, and a greater degree of contentment and quiet happiness will prevail.

CHAPTER VI.

PUBLIC HEALTH LAWS—STATISTICS OF DEATHS FROM PREVENTABLE DISEASES—EFFECTS OF IMPURE AIR—VENTILATION OF DWELLINGS — QUANTITY AND QUALITY OF WATER-SUPPLY—SEWERS AND SEWAGE.

PUBLIC HEALTH is that branch of medical science which treats of the prevention of disease, and the preservation of health by attention to well-known physical and physiological laws.

The science of hygiene has within the last few years gained special attention from statesmen, medical men, engineers, ministers of religion, and many of the more intelligent of the community, not, however, before the ravages of preventable disease were manifest to the most superficial observer; we have had, therefore, efforts made to prevent such terrible scourges as cholera, typhus, typhoid, scarlatina, &c. &c.

Laws have been enacted having for their object the welfare of the community, but, alas! as is too often the case, we are backward in appreciating anything that is for our good; in many cases, therefore, we have authorities simply obeying or carrying out the law nominally, instead of overlooking its defects by carrying out its objects with a will. We have

had officers and boards appointed, who are content to look on at the progress made in other districts, unless they are awakened to their sad state by the visitation of some epidemic, which carries off numerous lives.

The waste of life and loss to the country from sanitary defects is truly appalling, when we consider the number of deaths from preventable disease alone. In coping with these evils, we must strive to educate the people to obey the laws of health. Sanitary authorities must do all in their power to remedy the existing evils, and perseverance in the good work will be crowned with success. We have, of course, many obstacles in the way; the increased value of provisions, fuel, house-rent, and taxes nullify to a great extent the good effects of the high wages now received by artisans and labourers; they, therefore, are in the same position as formerly, namely, breathing vitiated atmospheres from overcrowded rooms, are insufficiently nourished, poorly clad, and are disobeying from day to day the simplest laws of health. 'For it cannot be denied that there are multitudes so heavily burdened with the load of vitiated heritage, and so hemmed in with the barriers of foul air, filth, and want, that teaching and preaching can only be felt as bitter mockeries, unless these barriers are first removed. Herein lie the duties of sanitary authorities; and in their compulsion by legislative means, there is at least some hope that amelioration and enlightenment may penetrate even to these depths' (Wilson's Handbook of Hygiene,

page 20.) What is said here in reference to our large towns applies also to our villages and rural districts.

In a lecture on 'The Waste of Life by Preventible Disease,' Mr. Brudenell Carter shows what havoc diseases which, with proper sanitary precautions, might be to a very great extent, if not wholly, prevented.

In five successive quinquennial periods from 1847 to 1871, Mr. Carter shows that these diseases, in the period from 1847 to 1851, destroyed 512·261 lives out of a total mortality of 2,028,367, or 1 in 3·96 deaths.

From 1852 to 1856	472,690	out of	2,082,346	or 1 in	4·4
„ 1857 „ 1861	375,085	„	2,168,087	„ 1 „	5·78
„ 1862 „ 1866	560,015	„	2,397,532	„ 1 „	4·28
„ 1867 „ 1871	562,487	„	2,476,731	„ 1 „	4·4

In round numbers 2,000,000 of people were destroyed in 25 years; and pursuing the subject further, we have other cases of sickness, for 1 in 6 is the average mortality in the London Fever Hospital. If we therefore multiply these by 6 we have 12,000,000 cases of disease, or about 600,000 cases every year. Mr. Carter even thinks this too low, probably 1 in 12 may be nearer the mark as regards the rate of mortality, and, if so, we have just double the number of cases as before mentioned. Estimating the duration of illness in the chief zymotic diseases, we have Dr. Buchanan giving the following as an average of time. Enteric fever, 6 weeks; typhus and relapsing fever, 5 weeks; fever of a slight character, 3 weeks;

and scarlet fever, 4 weeks; or 4½ weeks on an average for each case. Mr. Carter, therefore, has calculated that the sum of 2,596,402*l.* to represent the immediate and direct annual pecuniary cost and loss by zymotic disease to the community, if it fell upon the wage-earning classes alone. We must also, in calculating the loss to individuals and the community, take into consideration the number of people who are more or less invalided during the remainder of their lives.

By pursuing the subject further numerous advantages might be shown to arise from a proper knowledge and appreciation of our powers of preventing disease, and thus we should prevent, by the adoption of proper sanitary principles, much misery and suffering.

In the year 1872 was passed the Public Health Act, dividing England into (1) *urban sanitary districts*, and (2) *rural sanitary districts*, each district being subject to local authorities. In the case of rural districts, the *rural sanitary authority* is formed of the guardians of the union or a local board is formed, the members of which are elected by the ratepayers. In this rural sanitary authority all rights, powers, duties, &c., of other Acts appertaining to the prevention of disease are invested.

It is the duty of every rural sanitary authority to appoint from time to time a medical officer or officers of health, an inspector of nuisances, clerk, treasurer, and such other servants as it may deem necessary for the efficient carrying out of the purposes of the Sanitary Acts.

The *expenses* of the rural sanitary authority are divided into *general* and *special*. *General expenses* are those of the establishment and officers, expense of disinfection, conveying infected persons, &c. *Special expenses* are for the construction of sewers, providing a supply of water, &c. The general expenses are to be payable out of a common fund to be raised out of the poor rate of the parishes according to the rateable value of each. Special expenses are to be a separate charge on each contributory place, the rural sanitary authority having power to issue a precept to the overseer or overseers of each parish or contributory place. The overseer to pay general expenses out of the poor rate and special expenses out of a rate levied for the purpose under the seventeenth section of the Sewage Utilisation Act, 1867.[1]

The rural sanitary authority have the same remedy for the recovery from overseers of the amount of their precept as guardians have for contributions of parishes.

The Local Government Board has power to declare, by provisional order, any rural sanitary district or any portion of any rural sanitary district or districts, to be an urban sanitary district, and upon such order being confirmed by Parliament the district shall become a local government district and subject to the jurisdiction of a local board, and the expenses incurred by such board in the performance

[1] See Glen's Public Health Act, 1872, p. 12.

of its duties under the Sanitary Acts shall be defrayed in the manner provided by the Local Government Acts.

Subject to the provisions of this Act, there shall be transferred and attached to a rural sanitary authority all powers, rights, duties, liabilities, capacities, and obligations within such district, to the exclusion of any other authority exerciseable or attaching by and to the sewer authority under the Sewage Utilisation Acts, and by and to the nuisance authority under the Nuisances Removal Acts, also of the Common Lodging Houses Acts, the Diseases Prevention Act, and the Bakehouse Regulation Act or Acts amending such Acts.

As is usual with many of our laws, numerous flaws and defects were soon discovered in putting the machinery in working order, but it has been, and is certainly a step in the right direction. Let us hope, therefore, that, after extended sanitary experience, further legislation may be accomplished. We have of course a commencement in the Bill passed during the session of 1875 for the consolidation of the existing Acts.

The Public Health Act (1872), by constituting one defined sanitary authority, with fairly defined powers and duties, in all rural districts, and requiring from it the appointment of all officers necessary for its effective action, has done away with the confusion and contradiction of the previous state of things, and rendered efficient sanitary work, within the limits

(as yet too strait) of the public health laws, practicable in every part of the kingdom.[1]

The carrying out of the Act of 1872, chiefly through the mistake of delegating the head of the department to that of the old Poor Law Board, who delegated the working of the Act to the inspectors of the Poor Law Board, who had no special knowledge of sanitary matters, and who caused sanitary matters to be subservient to out-door relief, has not been so satisfactory as one could have wished.

'If the poor-law inspectors had been definitely instructed to reduce the sanitary organisation—contemplated by the Public Health Act, 1872—to confusion, the results of their labours to the present time could not have been more deplorable. Here one inspector advises the appointment of the Poor Law medical officers as medical officers of health, each in his own district, and an inspector of nuisances for a union of several such districts; and the Local Government Board confirms the arrangement. There an inspector discourages the appointment of Poor Law medical officers as officers of health, and urges that a county or a combination of several unions should be formed into a medical officer of health's district, and that an inspector of nuisances should be appointed for each union; and the Local Government Board confirms this arrangement also. Elsewhere an inspector propounds a scheme in which a medical officer of health and inspector of nuisances are to be

[1] 'Practitioner,' vol. x. p. 318.

appointed for a large area, with the Poor Law medical officers and relieving officers acting as assistant officers of health and assistant inspectors of nuisances; and this scheme also is approved by the Local Government Board. The latest instance of the large area mania is a scheme advertised in the *Local Government Chronicle* of 29th March, in which it is gravely proposed to elect a medical officer of health for a district having an area of above a thousand square miles, and a population of over a quarter of a million! Now, Mr. Stansfield, in the statement to which reference has been made, said of the Public Health Act, 1872, that it imposed upon the sanitary authorities created by it in every locality "the duty of a minute inspection of premises in order to prevent nuisances, and there in his mind arose its great future work." And yet, without exception, the arrangements made, or proposed to be made through the arrangements of the Poor Law inspectors, were under such inspection as is here contemplated impossible.'[1]

Since the passing of the Bill of 1872, we have had a measure introduced and passed through the House which will have a beneficial effect on the health of women and children, namely, the Factory Amendment Act. The important provisions of this Bill are for women and children; 56 hours per week as the time of employment, the age of half-timers to be fourteen years instead of thirteen years,

[1] 'Practitioner,' vol. x. pp. 321, 322.

and after 1875 ten years of age to be the lowest at which children shall be employed.

The Public Health Act of 1872 was found to be insufficient for many districts in regard to water-supply, sewerage, drainage, &c. Mr. Howard, of Bedford, points out these defects with remarkable clearness in a paper on the subject in 'Public Health,' vol. iii. p. 70. He says 'one of the chief and most perplexing difficulties arises from the number of Acts of Parliament partly in existence and partly repealed, also from the mixture in the Acts of urban and rural provisions in such a way as to render it a matter of considerable doubt to all ordinary persons what the law really is, and causing much trouble even to experts. The new General Act repealing all existing Acts, so framed that the provisions relating to urban and rural authorities, to gas, water, &c., shall be separated.

'The defects in the rural sanitary laws are chiefly manifest in the provisions which deal with (1) water-supply, (2) sewerage, (3) overcrowding, (4) infectious diseases.

'(1) With respect to water, the law gives power to the sanitary authority to cause to be provided a necessary supply of water to a house without a proper supply, providing it can be furnished to it at a rate not exceeding twopence per week. This rate of twopence is found to be totally inadequate; practically there is no power to compel an owner to provide a good supply of wholesome water, and though under the Act of last session power is given to magistrates

to close a well or cistern, people may still be compelled and are at liberty to draw their supplies from even more objectionable sources. Whilst feeling the necessity of not pushing sanitary regulations too far, I do think that a house which has not a decent water-supply ought to be condemned as unfit for human habitation.

'(2) In the matter of sewers and sewage, when new cottages are built, the sanitary authority can compel owners to make suitable provision; but the law gives no power to compel an owner of any existing cottage to provide it with a privy or closet, and if he has one, and pulls it down, there is no power to make him build another.

'(3) As to overcrowding, this is a question of no little difficulty; still, as matters stand, there is no law to prevent a dozen grown-up people, if of one family, living and sleeping in one room. The Act of 29 & 30 Vic., c. 90, and the Nuisances Removal Act (1865) appear to clash; perhaps the simplest method would be to fix a minimum space for each individual, and, in accordance, give powers to sanitary inspectors to prohibit overcrowding.

'(4) As to infectious diseases, owing to the circumlocution now necessary where disinfectants are required, disease is often spread half over a village before steps can be legally taken to arrest it; power should be invested in the sanitary authority, upon an *ex parte* order of a magistrate, at once to disinfect any such premises in case of default upon the part of the occupier. Powers should also, I venture to think,

be given to sanitary authorities to erect or hire houses to be used as hospitals, without having to wait for sanction of the Local Government Board. As a further precaution against the spread of infectious diseases, some amendment of the Act of 29 & 30 Vic., c. 90, is required, with a view to prohibit children from an infected house going to schools or other public places.'

A more unsanitary condition could scarcely be imagined than some of our rural districts are in at the present time. This is doubtless owing to building of dwellings without any regard to the disposal of sewage, removal of refuse matters, and attention to a proper supply of wholesome water.

Districts which ought to present the least possible death-rate, at all events from infectious diseases, are, owing to the neglect of sanitary measures, in scarcely a better state than some of our large towns.

The majority of dwellings in our rural villages for the labouring classes are built without any regard to system or regularity, have low roofs, small and ill-ventilated rooms, and many of them have no back doors or apertures, so as to allow of a free circulation of pure air. The slops are thrown on the road side, and there is no drainage, therefore this filth penetrates the soil in close proximity to the dwelling. The privy and ashpit is in close relation, and the stench from this in hot seasons of the year is abominable.

The water-supply is from wells, springs or running brooks, the majority of which are polluted by

the slops from the houses, as well as from decaying animal and vegetable matters; often enough we have shippons and pig-styes close at hand, with a filthy midden and pool all around it, the liquid manure permeating the soil and contaminating the water-supply.

Nearly all the reports of medical officers and nuisance inspectors for combined and rural sanitary districts present descriptions of these defects, and it is only necessary to quote from a few of these to show the necessity we have for sanitary improvements.

The following is an extract from a report of Mr. Davenport, the indefatigable inspector of the Nantwich Sanitary Authority:—'Broad Lane forms a somewhat populous portion of the township of Stapeley, and it will, no doubt, be remembered that a meeting of property owners here was held some considerable time back, to consult as to the means of improving the water-supply, and the result of that meeting was that the landlords agreed to take steps to provide a better one. Nothing, however, has been done, and the bulk of the houses are dependent upon ditches which convey water from the higher portions of the township. That the water is open to pollution in its course is only what may be expected, and in the lane itself the sewage from the houses, finding its way into the ditches, becomes so much mixed up with the flow that it is only by trespassing that the less polluted water can be obtained. In one instance a ditch full with sewage, &c., was only separated from

the hole or ditch where drinking water was obtained by numbers of people by a yard or two of earth thrown into the ditch. Foul ditches running at the backs of the houses into which slops are thrown, and privies and pig-styes empty or leak, are what may be termed the general drains for the majority of the houses, and the water and drainage are so mixed up that I question whether many would care to know the history of what they drink.'

I extract here a portion of the report of Dr. Molyneux, medical officer of health for the township of Upholland, a rural district which should be comparatively healthy from its situation. He says, 'During the past quarter our death-rate has been rather heavy. We have had no less than eleven fatal cases of scarlet fever, of which three have occurred at Tontine. It is a wonder to me there have not been more fatal cases here, for, as stated in the previous report of mine, the place is in a very filthy condition, the roads, the yards, the cesspools, in short, the everything are alike in that respect. Two of the cases of fever took place in the village, one being in School Lane, a street I have previously reported as being without any sewer. Two cases occurred at the bottom of Dean Wood, near the powder magazine. These houses and their surroundings are simply disgraceful; overcrowding is the rule; in wet weather, the water, so to say, runs through the houses; there is no drainage, the outside accommodations are tumbling down, the contents of the cesspools connected therewith run on the public footpath,

and slops and other refuse are thrown out on the ground in close proximity to the road. The drinking water is obtained from Dean Brook, and is not fit for human consumption, being much contaminated with refuse and decomposing animal matters. I need not say that under these sanitary conditions one can hardly hope for the recovery of a case of scarlatina.'

In reference to the subject of overcrowding, I must quote again from a report of Mr. Davenport, on Buerton, another Cheshire village, as I am sure that this is no exception. 'At one cottage in which there was only one miserable bedroom about 13 feet by $8\frac{1}{2}$ feet by $6\frac{3}{4}$ feet, and containing about 750 cubic feet of air-space only, I found nine persons occupying it; and at the time I inspected it I found the corpse of a child laid out at the foot of the bed underneath the window. In addition to the overcrowding I saw that the house lets in the rain. There was no back door—no through draught; the lower room was of the smallest possible dimensions; and the drainage round the house caused a great nuisance. The closet—if it may be called such—is nearly down, the walls were chiefly composed of clay and windings about $4\frac{1}{2}$ inches thick, and in places you could see through them. At another one-bedroomed house, I found seven occupants, consisting of grandfather, husband and wife, and four children, all sleeping in about a 1,000 cubic feet of air space.'

When we have these sanitary defects it is no wonder that the death-rate of villages should be so

high. Of course now it is below that of large towns; therefore with improved sanitary arrangements we should expect a great improvement in health and a minimum death-rate.

It has been proved by experiments carefully undertaken that the relative proportion of the gaseous constituents of the air do not vary much. Pure air has been found by the analysis of Dr. Angus Smith to consist of 20·98 volumes of oxygen, 79·02 volumes of nitrogen, and about ·033 per cent. of carbonic acid, watery vapour, and small traces of ammonia. The gases are not combined with each other, being only mixed together. The amount of aqueous vapour mainly influenced by the temperature therefore fluctuates greatly. The ammonia exists in very minute traces as the carbonate, chloride, or sulphate.

Effects of Impure Air.—It may be readily understood how a vitiated atmosphere not only proves injurious to healthy people, but also prevents others who are sick from recovering with the rapidity they otherwise would do, could they breathe a pure atmosphere.

Air impregnated with noxious gases, such as sulphuretted hydrogen, carbonic dioxide, carbonic oxide, and carburetted hydrogen, acts injuriously on the health of a person breathing them, and if sufficiently concentrated will prove poisonous if inhaled for any length of time.

Irritating gases, such as are given off in chemical and other works, give rise to bronchial affections,

inflammation of the lungs, and eye diseases. Mineral substances suspended in minute particles in the atmosphere produce diseases of the respiratory organs and organs of digestion by mechanical means alone. Miners, stonemasons, and workers in the pottery trade, as also steel-grinders, suffer from pulmonary consumption to a greater extent than others, especially if ventilation in the works is deficient.

Specific poisons, such as those which give rise to small-pox, typhus, scarlet fever, and measles, are supposed to be present in the atmosphere contaminated by persons suffering from these infectious diseases.

Dr. Henry MacCormac, of Belfast, is of opinion that the respiration of pre-breathed air is the chief factor of pulmonary consumption. Air rendered impure by respiration produces headache, heaviness, languidness, and often nausea.

Air surcharged with the products of combustion is more or less injurious, if in a concentrated form; their diffusibility with the general atmosphere, however, renders them much less injurious than they otherwise would be.

The maintenance of pure air will be considered under the head of ventilation.

Air is contaminated by—1, respiration of man and animals; 2, effluvia from sewage and refuse matters; 3, noxious vapours arising from manufactories; and 4, from exhalations in marshy districts.

'Every local sanitary authority may make bye-laws with respect to the following matters: that is to say—

'(*a*). With respect to the level, width, and construction of new streets, and the provision for the sewerage of such streets.

'(*b*). With respect to the structure of walls of new buildings, for securing stability and the prevention of fires.

'(*c*). With respect to the sufficiency of the space about buildings, to secure a free circulation of air, and with respect to the ventilation of buildings.

'(*d*). With respect to the drainage of buildings, to waterclosets, privies, ashpits, cesspools, in connection with buildings, and to the closing of buildings unfit for human habitation, and to prohibition of their use for human habitation.'[1] [2]

In regard to the construction of dwellings for human habitation, the legislation has not entered into sanitary principles, but has been satisfied in giving power to local authorities to make bye-laws which are to be approved by the Secretary of State.

For healthy habitations Dr. Parkes gives the following conditions:—

1. A site dry and not malarious, and an aspect which gives light and cheerfulness.

2. A ventilation which carries off all respiratory impurities.

[1] Local Government Act, 1858, sec. 34.

[2] Vide Wilson's Manual of Hygiene, Appendix, p. 358.

3. A system of immediate and perfect sewage removal, which shall render it impossible that the air shall be contaminated from excreta.

4. A due supply and proper removal of water by means of which perfect cleanliness of all parts of the house can be insured.

5. A construction of the house which shall insure perfect dryness of the foundation, wall, and roof.[1]

Where necessary, the soil should be drained before any building is built thereon, and the site selected should be open and cheerful; free movement of air through the rooms, without draught, should be especially sought for.

The rooms of a healthy house should be airy, large, and light. The windows should always be so constructed that they will open without much difficulty, and should reach near to the ceiling. No bedroom should be of less dimensions than 1,000 cubic feet.

The water-closet should be at some distance from the house, or if in the house should be where the light has easy access, and ventilation readily effected. The soil-pipe should pass down the wall outside the house, and should be as free from bends as possible. *It should be ventilated by a pipe carried up higher than the house, so that sewer gases may escape into the atmosphere.*

If a cesspool be employed it should be erected at some distance from the house, water-tight and

[1] Opus cit. p. 303.

small, so as to require frequent emptying; and should be so arranged that dry earth could be employed, or on the system of Moser's dry closet.

The difficulty of erecting dwellings either in towns, villages, or rural districts, for the working-classes is the enormous cost, which causes the rental to be so high, in many cases, that without sub-letting a portion of the house many are not able to pay the rents asked. We have seen, and it is the experience of others, that in cottages suitable only for a married couple with two or three children, inhabited by at least two families, consisting of from seven to nine members each, such a state of matters is not only injurious to the health of the individuals, but lowers their moral state to much below what it ought to be in a civilised or any country.

The evils of overcrowding are numerous, both morally, socially, and physically, and from this cause we have a very able assistant in rendering the people of this country debilitated, drunken, and depraved. On the subject of house accommodation for the labouring classes, Dr. Wilson says, 'Where the ground rental is low, the cheapest and most commodious form of labourer's cottage is one without any upper storey. Thus, according to Mr. Allen, in his "Manual on Cottage Building," a cottage consisting of a living-room for general every-day uses, a bedroom for boys, a bedroom for girls, a small wash-house, a storeroom and closet, could be built for 100*l*., provided all the rooms are on the ground floor, and that two such cottages be ranged side by side, so as to be spanned

by the same roof, and contained within four walls forming a simple parallelogram. The row of cottages proposed by Dr. Hunter in the seventh report of the Medical Officer of the Privy Council provided for a front and back kitchen in each cottage, and two bedrooms overhead. The kitchens were to be paved with brick or tile, "the front about 11 feet by 11 by 6 feet 8 high; the back about 11 by 8 feet 6; ceiling would be unnecessary. There should be four sliding windows, a grate with an oven, a boiler in the back kitchen, a little fireplace in one bedroom, and a Welsh slate roof, the bedrooms being ceiled.

"Such houses might be supplied for 50*l*., or 1,500*l*. for the thirty."

'In this plan, and, in fact, in almost all plans for cottage construction, the cubic space allowance is very limited, so that overcrowding to a greater or less extent is sure to prevail at times. Cottages which are scarcely roomy enough for a married couple and two or three children, become occupied by much larger families, or the family increases in number, year after year, while the bedroom accommodation remains the same. The initial space, therefore, should be ample enough to meet the requirements of, at any rate, moderate family increase; and when a number of cottages are built in the same locality, they should be of different sizes, to suit small and large families alike.'[1]

VENTILATION.—For the rarefication of impure air it

[1] Vide 'Wilson's Manual of Hygiene,' pp. 194, 195.

is necessary to attend to the ventilation of houses and workshops; in fact, all public and private buildings.

Dr. Parkes states that an adult man, not doing excessive work, may be considered to give to the atmosphere six cubic feet of carbonic acid every hour. The average amount of carbonic acid impure air contains is estimated at 0·4 per 1,000, or 4 volumes per 10,000; it is evident, therefore, unless we have a supply of pure air, and a removal of the vitiated atmosphere, we should soon be unable to breathe in our rooms; it is, however, sufficiently obvious that we cannot have the atmosphere of our rooms as pure as that outside, therefore in every dwelling-room there is some impurity of the air. From experiments made by Drs. Parkes and Chaumont, it appears that the organic impurity of the air is not perceptible to the senses until the carbonic acid rises to the ratio of ·6 per 1,000 volumes. Dr. Parkes says, 'I would propose, then, to adopt the amount of ·6 per 1,000 volumes of total carbonic acid (initial and respiratory) as the limit of impurity. I admit that I am not able to show by direct evidence that impurity, indicated by ·7 or ·8 or even 1 volume of carbonic acid per 1,000, and organic impurities in proportion, is injurious to health.'[1]

The amount of fresh air, therefore, which is required to keep up a perfect state of health can be calculated by fixing on a standard of purity, and when the requirements are known the size of the rooms can easily be ascertained, with the dimensions

[1] Opus cit. p. 119.

of the inlets and outlets of air. On this subject, again, Dr. Parkes's admirable remarks may be quoted. He says, 'If the standard of practicable purity, viz., ·6 of carbonic acid per 1,000 volumes (of which ·2 is derived from respiration), is considered too high, and if ·7, ·8, or ·9 be taken, the amount of air required per head per hour will be 2,000, 1,500, and 1,200 cubic feet respectively. If the emission of carbonic acid is taken, not at ·6 cubic feet per hour, but as something less, as in the case of women and children, a less amount of air would suffice, and can be calculated at once from the formula. The amount of air actually entering a room inhabited by men may be ascertained with considerable precision by determining the amount of carbonic acid, provided there be no other source of vitiation of the air than respiration. If the total carbonic acid amount, for example, at the end of an hour, to ·9 per 1,000 volumes, of which ·5 is from respiration, the total amount of fresh air already in or entering in the hour has been 1,200 cubic feet.'[1]

According to the same author, 750 to 1,000 cubic feet should be the minimum allowance of the initial air space, as a change equal to four or three times per hour is all that can be borne under the conditions of warming in this country.

As a means of ventilating dwellings, we have two modes, viz., natural and artificial ventilation.

1. *Natural ventilation.* We have the power of

[1] Opus cit. p. 121.

diffusion, which obeys certain laws, according to density. By this means air has power of diffusion through brick walls, but only to a slight extent when plastered, and is, therefore, of itself insufficient as a means of ventilation. The wind acts as a ventilating agent of great power, but owing to its variable nature it is difficult to use as a means of ventilating houses. The wind is, of course, caused by unequal weights of air, and this again may be considered separately as a means of natural ventilation. We have, owing to unequal weights of air, the principal mode of effecting ventilation; the cold air outside enters the rooms of the house, where it displaces the warm and foul air; it is warmed and expands, then again escaping to give place to more cold air, which goes on through every inlet and outlet, till the air outside is of the same temperature and density as the inside air.

2. *Artificial ventilation* is effected either by *propulsion*, that is, where the air is forced into and through a room, or by *extraction*, when the air is drawn out of the room.

We have artificial ventilation established in dwelling-houses by open fire-places; the chimney acts as a ventilating shaft whether there is a fire in it or not. The windows of a house, also, are used for admitting a supply of fresh air, as well as letting out the foul air contained within.

There are numerous plans of ventilating rooms, most of them on the same principle; but to do more than indicate the means of purifying the atmosphere

of our dwellings would be overstepping the limits of this chapter.

We may note, however, that every sanitary authority ought to pay particular attention to the ventilation of new houses to be built in their district, as well as improving that of old buildings.

SUPPLY OF WATER.—The Legislature has made abundant provision for the supply of good water, but has not made it compulsory on the local authority.

'Section 75. Public Health Act, 1848 (11 & 12 Vict., c. 63). And be it enacted that the local board may provide their district with such a supply of water as may be proper and sufficient for the purposes of this Act, and for private use to the extent required by this Act.'[1]

It has been observed, and wisely, that 'next to the food of the people, water is the most important requirement for every community, and an abundant supply of pure water is not only of primary importance in a sanitary point of view but one of the greatest blessings of life.'[2]

In rural districts, as has been observed, the supply of water hitherto has been limited and drawn chiefly from wells and running streams, which in summer time have been almost dry. Urban districts are much better off in this respect, as most of our towns are provided by means of large waterworks.

[1] Smith's 'Manual for Medical Officers of Health,' p. 101.

[2] Paper by Mr. Howard on 'The Water Supply of Villages,' 'Public Health,' vol. ii. p. 339.

It is therefore one of the chief duties of the rural sanitary authority to see that a proper supply is furnished in the districts under their supervision. In the majority of instances they will be advised by their medical officer of health and engineer as to the best mode of obtaining an ample supply for the necessities of the people.

We shall consider the three *chief* modes from which a supply of pure water may be obtained. They are—1. By collecting and storing in reservoirs from springs and natural streams; 2. By collection of water-fall (rain-water); and 3. By wells, springs, and borings.

1. *Reservoirs, collecting from streams and springs or from lakes* (*waterworks*).—Water may be supplied from a lake, if it is of sufficient elevation above the level of the district, by force of gravity, if not by means of pumps, when conveniently near the same district. When water is derived from streams, rivers, or gathering grounds, storage in reservoirs is essential. But a district may be supplied from a river if it be sufficiently large and constant.

In the case of storage in reservoirs, the waterworks usually comprise a dam or weir, for maintaining part of the river at a constant level, storing or settling ponds, filtering apparatus, and pumping engines. The channels of gathering grounds may be small streams, or rivers, or these supplemented with closed drains.

The amount of storage room will depend on the

quantity used and the facility for replenishing. When these conditions are known it can be calculated in this way: 'The number of gallons required daily for the whole population must be divided by 6·23 to bring into cubic feet, and multiplied by the number of days which the storage must last, the product is the necessary size of reservoir in cubic feet.'[1]

The *reservoir* or *reservoirs* should be capable of holding a supply for six months, and a site which can supply the required storage room with the least embankment and the smallest area laid under the water is to be preferred.

The embankment must be of sufficient strength and stability, and must be made water-tight by a core of clay puddle, the inner slope being protected from the action of the water by stones, and from the action of the weather by green sods. The greatest care ought to be taken in the construction of the embankment so as to prevent animals from burrowing into it. Every collecting or impounding reservoir ought to be provided with an overflow weir to permit the discharge of the increased supply at the time of floods, from the drainage area; and this should be supplemented with a *diverticulum* or bye-wash which would divert the streams supplying the reservoir, and thus prevent fouling of the store-water.

At the bottom of the reservoir there should always be a discharge-pipe and a cleansing-pipe, so

[1] Vide Parkes' 'Hygiene,' p. 10.

as to remove the sediment which collects, the latter being level with the lowest part in the reservoir and discharging below the embankment into the natural water-course. A culvert in the embankment founded on the solid rock, and built of stone or brick, should carry these pipes. The discharge-pipe bends upwards into the reservoir, and at the lowest working level has a series of inlets, these inlets being guarded against the entrance of small stones and other bodies. Sluices for both pipes should be worked from the sluice-tower.

The water should pass through filter-beds before passing into the tanks or conduits for distribution. After the water has passed through the filter-beds into tanks, or another reservoir for the purpose, it is distributed by means of conduits or cast-iron pipes, which should be coated inside with pitch or some other substance, so as to prevent corrosion. The terminations of the pipes should be supplied with scouring-valves, through which stones and sediment may be washed.

Sluice stop-cocks and valve-cocks are provided at the different bends and summits of the pipes, so as to permit of repairs, scouring out of stones and sediment, and also to allow the air to escape.

House-pipes are required of some flexible material, therefore lead is commonly used. Leaden pipes should be coated inside with block-tin (Mr. Haine's patent) or some other substance, so as to prevent the action of the water on the lead.

In selecting this mode of supply, which by some has been represented as far too common, we must be

careful not to select water from a river or running stream that is polluted above, either by town sewage, or by waste water from large works; such water once polluted, no matter how filtered, is not what it ought to be for domestic purposes, although filtering through beds of sand, especially when this is accomplished on the intermittent plan, may not be loaded with any large amount of impurities, and much of the organic matter may have been rendered innocuous, still the principle of polluting and afterwards purifying water for use is totally wrong.

Distribution.—Houses are supplied with water from reservoirs on one of two systems, either (1) *intermittent* or (2) *constant* supply. The intermittent plan of supply should always be condemned where the other is practicable. Many objections may be urged against this plan; the water is only turned on for two or three hours during day, and the cisterns filled in this mode of supply, unless proper provision is made for the inspection and cleaning out of these cisterns, they are liable to get fouled, and the water contaminated; moreover, there is danger of contamination from sewer-gases passing in through the overflow-pipe; the pipes also, from being alternately wet and dry, collect dust and filth from drains. The cisterns should be made of slate, and have wrought-iron supply-pipes, as these are much better than lead, according to Mr. Rawlinson. The size of the cisterns may be easily ascertained, as we should allow 20 gallons for each person per day. The constant system of supply requires no cistern, as the

pipes are always full, and if we have high-pressure service very little is wasted. The plan of supply on the intermittent system ought to be abolished in those districts where it is in force, and the constant supply substituted.

In supplying districts with water bye-laws or rules relating to the supply must be drawn up and adopted, so as to prevent misuse and waste of the water.

2. *By collection of water-fall (rain-water).*—The collection of rain-water consists in imitating the natural processes of collection (such as we see occurring naturally in depressions of the surface and commingling of small streams to form rivers), in directing to and arresting at some point rain or the streamlets formed by rain.

'Rain-water is collected from roofs, or occasionally from pavements and flags or cemented ground; in hilly countries, with deep ravines, a reservoir is sometimes formed by carrying a wall across a valley which is well placed for receiving the tributary waters of the adjacent hills, or on a flatter surface trenches may be arranged, leading finally to an excavated tank.

'The collection of the surface water which has not penetrated is usually aimed at, but it has been proposed by Mr. Bailey Denton to collect the subsoil water by drainage pipes, and thus accomplish two objects—to dry the land, and to use the water taken out of it.'[1]

[1] Dr. Parkes's 'Practical Hygiene,' pp. 6, 7.

Dr. Wilson, in his 'Handbook of Hygiene,' speaking of rain-water, says, at page 130: 'In this country it is seldom stored except for washing purposes, but in Venice and many other continental cities it is collected in underground reservoirs, and constitutes almost the sole source of fresh-water supply to the inhabitants. It is usually collected from the roofs of houses and occasionally from paved or cemented ground.'

3. *By wells, springs and borings.* — 'In sparsely populated districts these surface wells constitute the usual source of supply, and if proper precautions be taken to guard against the soakage of animal excreta into them, they usually yield a wholesome water; but in villages and towns the soil often becomes so saturated with impurities that it is next to impossible to prevent their pollution. In crowded localities, therefore, they should always be regarded with suspicion, and, as far as possible, their use should be discontinued. Deep wells, on the other hand, are not open to this objection, because they are generally sunk through an impervious stratum, which prevents the infiltration of any surface impurities, and at the same time serves to keep down the water in the porous strata beneath.'[1]

Wells, as a rule, should not be used to supply water for drinking or cooking purposes, unless properly built in cement, for the water is so liable to be contaminated with excreta.

[1] Vide Wilson's 'Handbook of Hygiene,' p. 137.

In the manual of Public Health edited by Hart, at page 255, we find an account of a pump in the neighbourhood where enteric fever had broken out, the use of which had been discontinued by the people in the neighbourhood because the water had become green and offensive. It was discovered shortly afterwards, when a portion of the wall behind the pump fell down, that a midden pit of semi-liquid filth and excrement was just on the other side of the wall directly over the well from which the pump drew.

Wells sunk in gravel beds are liable to be affected by seasons of drought, though at other times may yield a pretty constant supply, unless they are situated considerably below the level of the surrounding country. On the other hand, borings in limestone formations or red sandstone usually yield a large supply, because these rocks may be looked upon as underground reservoirs owing to their saturation with water. On the subject of artesian borings, we have the following remarks from Hart's 'Manual of Public Health,' p. 256:—'But if, instead of superficial wells (which may indeed go to a considerable depth in subsoil without the character of their water being much improved), we have wells specially constructed so as to keep out the subsoil water—that is to say, lined with masonry, constructed in cement, and at the bottom of these wells borings through impervious strata into water-bearing strata beneath—the circumstances of the case are quite altered, These, which are known as "artesian wells," often afford a very large supply of excellent water, which

rises through the boring into the well, and either overflows or has to be pumped out of it. The water is derived from the rainfall of districts at some distance, where the outcrop of the water-bearing stratum tapped appears—that is to say, where this stratum comes to the surface; the water percolating through the pervious rock is confined within it when the rock is covered by an impervious stratum of clay.'

Wherever it is practicable, the system of water-supply which ought to be adopted is the plan first mentioned, by collection and storage in large reservoirs, and this distributed on the constant service supply system to each house. Waterworks on a large scale might be made to supply one or several villages that lie in close proximity: by this means we should insure an efficient supply of pure water.

It will, however, be found impracticable in some districts, and where it is so, some other means must be adopted. The system of collecting the rainfall so strongly recommended by Mr. Howard should be adopted, and sufficient might be collected from the roofs of the houses, and in the case of farm-houses, an ample supply might be obtained from the roofs of the house and outbuildings together, providing proper reservoirs for storage were provided. In some cases springs may be made available for the supply of water to our rural populations, taking care that proper wells are sunk and well-cemented, so as to avoid their possible contamination with animal organic matters.

QUANTITY:—The quantity of water supplied is as

important as the quality, for should a pure supply be obtainable only in small quantities, not sufficient for domestic and other purposes, then we shall have disease arising and spreading through filth.

The quantity of water required per head per diem will of course vary with the habits of the people. From 20 to 25 gallons has been estimated as the average and 4 gallons for each adult, the least amount that ought to be used according to Professor Parkes. Fifteen gallons per diem is allowed to the soldier, and this is used for different purposes, no extra allowance being made for the wives and children. Dr. Parkes has calculated the amount used by a man in the middle classes as follows[1] :—

	Gallons daily, per one person.
Cooking	·75
Fluids as drink (water, tea, coffee) . .	·33
Ablution, including a daily sponge bath, which took 2½ to 3 gallons	5·
Share of utensil and house washing . .	3·
Share of clothes (laundry) washing estimated .	3·
	12·

Mr. Muir states that from experiments in model lodging houses, 7 gallons daily were used per head, Mr. Easton found he used about 12 gallons per head in his own house, of which about 5 were for closets, leaving 7 for other purposes.

The quantity required will also vary as to the proportions required for trade purposes, and water-closets, but the following amount for all purposes

[1] Vide Parkes, Opus cit. p. 3.

has been calculated for the daily amount per head of the population :—

	Gallons.
Domestic supply (without baths or closets)	12
Add for general baths	4
Water-closets	6
Unavoidable waste	3
	25

The amount of 20 to 25 gallons per diem would seem to be what is in reality the amount supplied to many towns.

	Gallons per head of population.
Lambeth	34
Glasgow	50
Nottingham	17
Norwich	12
Derby	14
Edinburgh	35
Liverpool	30
Sheffield	20
Average	26½

By taking 8 Lancashire towns we have 20 gallons as the average per head of the population per diem.

	Gallons.
Ashton-under-Lyne	12
Bolton	25
Bury	20
Liverpool	30
Manchester	21½
St. Helen's	20
Stockport	14
Wigan	17½
Average	20

[1] Vide Parkes, Opus cit. p. 6.

QUALITY OF WATER.—After seeking out a source of water for the supply of a rural district, and ascertaining that the amount is abundant for all purposes, the next step to be taken is to ascertain its fitness for domestic purposes.

To do this thoroughly, a sample of the water must be taken in a clean Winchester quart bottle, and sent to a chemist for analysis, unless the Medical Officer of Health is competent to undertake the work.

Dr. Parkes has classified all drinking waters, and he thus makes four classes, viz. :—

1. Pure and wholesome water.
2. Usable.
3. Suspicious.
4. Impure.

The following are his characters for each :—

'1. *Pure and Wholesome Water. Characters.*—It should be transparent, without suspended matters, smell, or taste, and be well aerated. The total solids should not exceed 8 grains per gallon, of which only one should be dissipated by heat, unless it be a chalk water, in which case the total solids should not exceed 14 grains per gallon of calcium carbonate, and should contain only traces of calcium sulphate. The matter destructible by heat (allowance being made for the decomposition of calcium carbonate) should be under 1 grain, and should scarcely blacken; the indications of nitrites should be absent; of nitrates and ammonium extremely slight.

'2. *Usable Water. Characters.*—It should be transparent and well aerated, without suspended

matters, or with only a small amount capable of easy separation by coarse filtration, without smell or taste. The total solids should not exceed 30 grains per gallon, and should consist chiefly of sodium and calcium carbonates, sodium sulphate and chloride, and with little calcium or magnesium sulphates. The reactions of ammonia, nitrates, and nitrites, should be quite inconsiderable. An exception may be made as respects the amount of total solids in the case of waters containing chiefly a mixture of sodium chloride and carbonate, in which case the conjoint salts may, it appears, run up to 50 grains, or even more per gallon, without apparent bad effects. The matters dissipated by heat should not be more than 3 grains per gallon, and there should be reason to think that the greater part of this is of vegetable origin.

'3. *Suspicious Water. Characters.*—Any water, if decidedly turbid, is suspicious, even if the turbidity be separable by coarse filtration, or if there be smell or taste. So also if the mineral matters are in large amount (over 30 grains per gallon), especially if consisting chiefly of calcium and magnesium sulphate, nitrate or nitrite, or chloride. If on drying and incinerating there is considerable blackening, or if any quantity of potassium permanganate is readily destroyed, or if the indications of nitrites and nitrates of ammonia are decided, the water is suspicious.

'4. *Impure Water. Characters.*—Any water so turbid as not to be purified by coarse filtration, or with a decided smell or taste, or containing very

large quantities of mineral substances (over 50 grains per gallon), and over 4 grains per gallon of destructible (presumed) organic matter, if at the same time the indications of nitrites, nitrates, and ammonia are large, is impure. If on evaporation to dryness and careful incineration there is not only great blackening, but a decided indication of nitrous acid fumes, or a smell of burnt horn, and if a large amount of potassium permanganate is rapidly decolorised, the water is impure.'[1]

It is almost unnecessary to point out which of these waters should be, and which should not be, used for domestic purposes. The first and second may be used, and also the third after it has been filtered or purified; the fourth class should not be used, unless it is thoroughly purified and filtered.

The chief reason why we should analyse water before using it for domestic purposes, is in order to ascertain the quantity of organic impurities it contains, and whether it is contaminated with fæcal or sewage matter.

The Rivers' Pollution Commission have laid down the following particulars for enquiry into the quality of potable waters, and have framed the tables in their report upon them :—

1. Organic Carbon } both due to organic sub-
2. „ Nitrogen } stance.
3. Ammonia.
4. Nitrogen in combination with oxygen, as in nitric and nitrous acids.

[1] Vide Opus cit. pp. 26, 27.

5. The total combined nitrogen.

6. Chlorine.

7 Hardening constituents.

The same Commission, in a review of the subject in 1870, arrived at the following conclusions, and consider any liquid as unfit to enter a stream which has the following elements in 10,000 gallons:—

1. Containing in *suspension* more than 3 parts by weight of dry mineral matter, or 1 part by weight of dry organic matter.

2. Containing in *solution* more than 2 parts by weight of organic carbon, or 0·3 part by weight of organic nitrogen.

3. Which shall exhibit by daylight a distinct colour when a stratum of it 1 inch deep is placed in a white porcelain or earthenware vessel.

4. Containing in *solution* more than 2 parts by weight of any metal, except calcium, magnesium, potassium, and sodium.

5. Containing, whether in *solution* or *suspension*, in chemical combination or otherwise, more than 0·05 part of metallic arsenic.

6. Containing, after acidification with sulphuric acid, more than 1 part by weight of pure chlorine.

7. Containing more than 1 part by weight of sulphur in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

8. Possessing an acidity greater than that which is produced by adding 2 parts by weight of real muriatic acid to 1,000 parts of distilled water.

9. Possessing an alkalinity greater than that

produced by adding 1 part by weight of dry caustic soda to 1,000 parts by weight of distilled water.[1]

In the examination of water we avail ourselves of three different modes, viz.:—1. Physical; 2. Microscopical; and, 3. Chemical. As previously mentioned, for a minute and accurate examination an expert ought to be employed; but for all ordinary purposes every Medical Officer of Health ought to be competent to examine water, and recommend its use or discontinuance in case of unfitness without submitting it to an expert.

Great attention is paid to the amount of solids per gallon in the examination of potable waters: 30 or 40 grains of solids do not warrant us, according to some authorities, in raising any objection to water intended for domestic purposes, nor are we justified in preferring water containing an exceptionally small amount of solids, for it has been remarked that exceptionally small solid residues are rather indicative of a certain proportion or degree of organic impurity.

The waters of the Kent Company and new supply to Guildford contain 26·5 and 19·7 grains of solids per gallon, yet, organically speaking, are almost as pure as distilled water, while Loch Katrine water, which supplies Glasgow, contains only 2·3 grains of solids per gallon, and belongs to the less pure drinking waters, as containing a large proportion of organic nitrogenous matter.

[1] Vide Smith's 'Manual for Medical Officers of Health,' pp. 117, 118.

Gases.—Water contains oxygen and nitrogen in solution in varying proportions, but they do not avail us much as evidence for judging of the quality of water.

Hardness of water is due to calcium and magnesium compounds, chiefly carbonates and sulphates. Carbonate of lime is held in solution by an excess of carbonic acid (carbonic anhydride).

The hardness does not affect it much for drinking purposes, unless it contains a large amount of solids per gallon; if it does not exceed 20 or 30 grains per gallon it is not of much importance. The degree of hardness of water is ascertained by Dr. Clark's soap test, and water is rendered less hard by his plan of treatment, namely, adding lime water to the hard water; by doing so we set free the carbonic acid which forms a carbonate with the lime thrown in, and allows the carbonate of the same, which it held in solution, to fall down also.

Nitrates and nitrites in water are evidence of previous contamination, and should always make us treat their presence with suspicion. We should ascertain the source of contamination if possible, for it is probable that albuminous matter of some kind, which has not been thoroughly oxidised, has found its way into the water. With the progress of investigation however, it has been found that we ought not to attach the same importance to the presence of nitrates as we were wont to do, for water devoid of nitrates may possibly have been contaminated with sewage matter, for aquatic vegetation destroys

nitrates, and fresh sewage is said to be free from nitrates.

Organic matters in water are indicated if present by the ammonia process or the testing for ammonia with Nesseler's solution, for a description of which we must refer to any one of the valuable works on 'Public Health,' or to Wauklyn and Chapman's work on 'Water Analysis.'

The limits which distinguish clean from unclean water have been the assignment of 0·6 or 0·7 milligrammes of albuminoid ammonia per litre, and no district ought to be served with water which oversteps this limit.[1]

Wauklyn and Chapman, in their work on 'Water Analysis,' observe at p. 38, 'When free ammonia exceeds 0·08 parts per million, it almost invariably proceeds from the fermentation of urea into carbonate of ammonia, and is a sign that the water in question consists of diluted urine in very recent condition.'

Water may be impure from mineral, animal, or vegetable matters, all of which may give rise to disease in some form or another.

It is owing to animal organic matter that we have dysentery, diarrhœa, cholera, typhoid fever, &c., for it has been conclusively shown in the philosophical reports of the medical officer of the Privy Council, that outbreaks of typhoid fever are owing to water contaminated with animal organic matter, either in the form of sewer-gases or fæcal matter which has

[1] Vide Hart's 'Manual of Public Health,' p. 324.

permeated the subsoil, and by some means got into the wells or cistern from which the water has been drawn.

We have had quite recently an example of this at Over Darwen, where there has been a very severe epidemic of typhoid fever. Over Darwen, being a town in Lancashire that has sprung up in a short space of time, and the necessary sanitary precautions ignored or totally neglected, hence when once the disease broke out it spread with amazing rapidity; it was also found on enquiry that the evacuations of a patient suffering from typhoid had been thrown out into a drain which was defective, and thus allowed the excreta to escape and contaminate the water from which the inhabitants drew their supply.

Dr. Herbert Snow was the first to show in 1849, conclusively, that cholera could be propagated through using polluted water, and it has been shown since during two or three epidemics of cholera that the proportion affected per 10,000 of the population, were much greater when supplied with the water of companies which was greatly charged with organic matter.

Water impure from vegetable matter has been known to produce ague and other malarious diseases, as well as diarrhœa.

Water impure from an excess of mineral substances gives rise to goitre, especially when the magnesium salts are in excess, as we see in Derbyshire in this country, and in some parts of Switzerland,

where it also gives rise to a fearful form of idiocy named cretinism. The carbonates of the mineral earths are supposed to be the least injurious, and the temporary hardness of water is not of as much consequence as the permanent. Dr. Parkes, before the Royal Commissioners on Water Supply, maintained that the hardness should not exceed 10 or 12 degrees, and Dr. Letheby thought a moderately hard water best for drinking purposes.

Calcium carbonate should always be in excess of other salts in hard waters. Excessively hard water is liable to cause dyspepsia.

'As a rule, then, soft waters are to be preferred to hard ones, and hard water should be softened, as far as it can be by Clark's process, before being distributed; while permanently hard water should be avoided.'[1]

Independent of the unwholesomeness of hard water, it causes a great waste of soap, and is not so advantageous for cooking purposes. It has been asserted that the interest on the Glasgow waterworks has been saved in soap, by supplying the inhabitants with a soft water, and also that the citizens of Dublin would save one penny per week by being supplied with Vartry water. Each degree of hardness of water is equivalent to the waste of $2\frac{1}{2}$ ounces of soap to the 100 gallons of water used.

Lead, mercury, arsenic, copper, and zinc may be a source of rendering water injurious, especially

[1] Hart's 'Manual of Public Health,' p. 261.

when it has been in contact for some time with any of these metals.

Action of Water on Leaden Pipes and Cisterns.—It is very important that the water supplied to a community should not become affected or rendered poisonous during its transit through the supply-pipes. There have been cases in which one-hundredth of a grain per gallon of lead has been found injurious, and Dr. Parkes considers that any amount over one-twentieth of a grain per gallon should be considered dangerous.

Soft waters and those containing organic matters, and nitrites, chlorides, &c., act more on lead than hard waters, and those containing carbonic acid, calcium, carbonate, phosphate, and sulphate.

Sewers and Sewage.—Highway Boards who have made sewers for the removal of nuisances in rural districts, have still control over them, although the Public Health Act of 1872 removed the control from sewer authorities in towns, vesting the right in the urban sanitary authority. This state of the law must continue to cause difficulties, and should therefore be altered, so that the rural sanitary authorities may have power over them.[1]

Construction of Sewers.—1. House Sewers; 2. Street Sewers.

1. *House Sewers* are generally from 4 to 6 inches in diameter for sink and closet drains, but for large house sewers may be up to 15 inches in

[1] Vide Hart's 'Manual of Public Health,' p. 73.

diameter. These are almost always made of round pipes of earthenware, the inside of which are well glazed.

2. *The Street Sewers* are built of brick and cement, in the form of an egg, the small end downwards; and these should be large enough for a man to creep through.

Street sewers should have a fall of from 1 in 50 to 1 in 300, or even less; and house sewers should have a fall of 1 in 48. There should be a velocity of not more than 4½ feet per second, or not less than 1 foot per second.

No sewers should join directly opposite another, and tributary sewers should deliver in the direction of the flow. For villages and rural districts pipe-sewers could be had in place of brick ones, as they are more easily laid and require less excavation.

It is necessary that sewers should be thoroughly and systematically flushed, so as to prevent the accumulation of filth and formation of deposits, which would decompose and give rise to sewer gases. Another important point in regard to sewers is ventilation; for if we have sewers well ventilated and systematically flushed, the danger from sewer gases is reduced to a minimum.

Main sewers should have a man-hole, tumbling bay, and a double ventilating arrangement at intervals of not less than 250 or 300 yards. The fall or tumbling bay should have a flap valve, so as to compel the gases to ascend through the ventilators. On a sanitary authority devolves by law the duty of sewering the

district, and on the private individual the duty of providing, subject to the approval of the officer of the R.S.A., inlets into the sewers provided at the public cost, and competent to drain his property.

Solid and fluid excrement from the bowels and kidneys ought to be removed as soon as possible, and the method for so doing may be described under the head of *Removal of Sewage.* That the removal of sewage forms a very important subject for the consideration of rural sanitary authorities, is evident from the injurious influence it has over the health of a district when it becomes a nuisance. Dr. Parkes makes the following appropriate remarks on the subject:—'It is highly probable that to barbarous and inefficient modes of removing the excreta of men and animals we must partly trace the great prevalence of disease in the middle ages, and there is no doubt that many of the diseases now prevailing in our large towns are owing to the same cause.'[1]

It is, however, chiefly in large villages and towns that difficulties arise in the consideration of any plan for the removal of excrementitious matters, slops, and refuse vegetable matters. I must here again quote the admirable remarks of Dr. Parkes. He says:—'When men live in thinly-populated countries, following, as they will then do, an agricultural or nomade life, they will not experience the consequences of insufficient removal of excreta. The sewage matter returns at once to that great deodoriser, the soil, and fertilising it, becomes a

[1] Opus cit. p. 339.

benefit to man, and not a danger. It is only when men collect in communities that the disposal of excreta becomes a matter literally of life and death, and before it can be settled the utmost skill and energy of a people may be taxed.'[1]

When taking into consideration the removal of sewage in a district, we must consider it in two parts, namely—1. Its collection ; and 2. Its disposal.

The *Collection of Sewage* is a matter of engineering, and when the outfall has been determined can always be accomplished. The *Disposal of Sewage Matter*, however, is of greater and apparently increasing difficulty, and although the various plans now in use will be described, it must be remembered that no one plan is suitable for every locality or district; but according to the circumstances of the surroundings, the sanitary authority must use its discretion in selecting a means for the disposal of sewage matters.

For the sewage outfall the acquirement of land is essential, either compulsorily or by agreement. Sewage matters cannot be turned into rivers without undergoing a process of purification, and if water be used as its carrier, there will be a large quantity to to be disposed of daily.

The rural sanitary authorities have power to acquire land sufficient for their wants, so as to dispose of refuse matters, by obtaining a special Act of Parliament. The law gives proprietors who are opposed to sewage works in close proximity to their

[1] Opus cit. p. 339.

houses, or on their land, a power of appeal, and then there is an enquiry into each individual case. Once the power is obtained the local authority can proceed to construct the main sewer, and for this purpose can purchase any rights as to sewers vested in other persons, and can enter upon any lands whatever where the surveyor may show it to be necessary. The public sewers constructed are to be maintained by the authority, who have power to alter, arch over, or improve them, or, if necessary, close up, or discontinue any that have become unnecessary. The sanitary authority is to see that no nuisance arises from the sewers, and see that they are properly cleansed, so that they may not prove injurious to the health of the inhabitants of the district.

The local authority has power to compel all buildings within 100 feet to be drained into its sewers, or into the sea if within that distance, and no house shall be built or pulled down and rebuilt unless complying with this regulation, in accordance with the report of the surveyor. The authority has also power to cause drainage to be constructed for ash-pits, water-closets, privies, earth-closets, if it be wanting; and should the owner fail to do the work, the authority has power to execute the work, and recover the cost as private improvement expenses.

The local sanitary authority has power under the Public Health Act, 1872, to close up ditches, sewers, and ponds, and undertake all works for the adequate sewering of a district, and also for obtaining an abundant water-supply. Adjacent sanitary autho-

rities may arrange with each other for the use of each others' sewers, or conjointly for sewage works, and the sewering of their respective districts by permission of the Local Government Board; and this plan of combination, if it can be agreed upon, has many advantages to recommend it.

We shall now describe the various systems for the removal and disposal of refuse matters. By refuse matters we mean such as form sewage—namely, excrementitious matters (urine and fæces), and slops, and also ashes, bones, skins, and refuse of animal and vegetable nature; such matters, in fact, that require constant removal for the sake of cleanliness, sweetness, and health.

1. *Ash-pits, Middens, and Cesspools.*—This plan of collection of refuse matters is the rule in towns and villages, but owing to its injurious influence on the health of the people, is giving way to better and more sanitary systems.

The great objection to cesspools and ash-pits is that generally the bottoms are not drained or flagged, and very often they are not properly roofed, and the rain washes through the ashes and refuse, which are allowed to be scattered about the door or opening through which they are thrown; the consequence is that the urine and dissolved portion of the fæcal matter percolates the ground, very often finding its way into the water-supply of the house, and the ashes always being wet, their absorbing powers are destroyed.

The midden should be small, roofed in, well-

ventilated, and water-tight—*i.e.*, the bottom flagged, or paved and cemented. The floor should be sloping, so as to keep the ashes dry, and they in their turn render the excrement dry also. It is also necessary that it should be a safe distance from the house.

On the Continent this system is carried out on a large scale, and the huge pits are named *fosses permanentes*, and are placed under the court-yards. They are rendered impervious by being lined with cement, and are ventilated by shafts rising some feet above the roofs of the houses. They are emptied three or four times in the year by pneumatic or air-tight carts, from which before filling the air is exhausted, and the refuse matters forced in by atmospheric pressure.

2. *The Dry Method.*—The two chief methods are Moule's earth closet and Taylor's dry closet.

(1) *Moule's earth closet* consists of a wooden box or chair, underneath the seat a bucket or receptacle, a reservoir for dry earth above, and an apparatus for measuring the quantity and passing it into the receptacle whenever the closet is used. About 1½lbs. of dry earth are required for the deodorisation of each stool (including the urine), and the closet is made self-acting by a handle similar to the one used for ordinary water-closets. The other urine and slops must be disposed of in some other way, and for the satisfactory working of this plan, the earth must be dried and sifted, and a sufficient quantity thrown into the pail before the closet is used.

Dr. Mouatt speaks highly of this plan as in use in India, and it appears to be peculiarly adapted for large institutions, and answers well at Broadmoor Lunatic Asylum, Reading Workhouse, and other institutions. It might very easily be adopted in rural districts where soil is plentiful and can be had in sufficient quantity.

The disadvantages of the system are the difficul ties of storing, drying, and procuring earth, and its inadequacy as a means of removing the whole of the refuse matter and slops.

For country villages and isolated buildings, Dr. Parkes thinks this system is almost perfect, where the proper management and necessary labour can be procured, when there is no difficulty of procuring and supplying dry earth and afterwards disposing of it. The earth can be used again after keeping a while and drying it before reusing, without losing its deodorising properties.

In Mr. Simon's report for 1869, Dr. Buchanan makes the following summary with regard to the working of the earth system:

'(1) The earth closet, intelligently managed, furnishes a means of disposing of excrement without nuisance and apparently without detriment to health.

'(2) In communities the earth closet system requires to be managed by the authority of the place, and will pay at least the expenses of its management.

'(3) In the poorer classes of houses, where supervision of any closet arrangements is indispens-

able, the adoption of the earth system offers special advantages.

'(4) The earth system of excrement removal does not supersede the necessity for an independent means of removing slops, rain water, and soil water.

'(5) The limits of application of the earth system in the future cannot be stated. In existing towns favourably arranged for access to the closets, the system might be at once applied to populations of 10,000 persons.

'(6) As compared with water-closets, the earth system has these advantages: it is cheaper in the original cost, it requires less repairs, it is not injured by frost, it is not damaged by improper substances drawn down it, and it very greatly reduces the quantity of water required by each household.' [1]

2. *Taylor's dry closet.*—A revolving disc worked by a lever connected with the closet seat, separates the urine from the fæces. The solids are retained on the disc until a complete revolution is made, by which time they are dry, and are then scraped off with a knife into a vessel beneath. When the seat is raised the disc moves round, and when closed a small quantity of ashes or ashes and disinfecting powder is thrown upon the soil. The urine runs off into a neighbouring drain or tank, and the whole apparatus is self-acting in connection with the opening and shutting of the lid.

3. *The pail system.*—We shall here mention the more common varieties of this method.

[1] Vide Wilson's 'Handbook of Hygiene,' p. 235.

Pail or trough system, in use in Glasgow and Edinburgh. In this plan, the closets are ranged in double rows and roofed in with a passage between them for the scavenger. They have slate seats and slate divisions between them. There is a pail below each seat, which is removed daily; and in connection with the privy there is a water tank for cleansing purposes.

The Eureka system.—Under the privy seats a box containing some deodorising mixture is placed, and allowed to remain till full, when it is closed with a tight-fitting lid and carted off to the manure manufactory. No slops are allowed to be mixed with the excreta, or put into the boxes.

In another plan of the pail system, ashes and excrement are thrown into the pails, and are emptied in the streets daily, when the refuse is removed by the scavengers.

Fosses Mobiles.—This is a system followed in many continental towns. The *fosse mobile* is a closed tube placed on a stand with wheels, and connected with different closets of a house by a descent pipe. When filled it is replaced by a similar one.

Tubs.—At Rochdale, they have a plan of using tubs made from paraffin oil casks sawn in two, into which some common salt is placed, or some fine ash and common salt. The tubs are removed without creating a nuisance, being provided with tight-fitting lids.

At Salford and some other towns, they have tubs

prepared on the *Goux system*. In this plan the tubs are lined with some dry material, such as dry ferns, refuse hay, chaff, straw, or any kind of dry vegetable refuse. The materials are mixed with a percentage of sulphate of iron or sulphate of lime. A mould is used to press the material to the sides and bottom of the tubs. Urine may be emptied into them, but a separate bin is required for the house refuse. These tubs are emptied once or twice a week according to circumstances. Unless the excreta is kept dry, this system has no advantage over the other plans.

Boxes which are removed daily or several times a week are in use at Leeds and Nottingham, and may be used with or without preparation. House refuse and ashes are collected in separate vessels.

Of all dry earth methods of removing refuse matter, Moule's earth closet is the best.

4. *Removal by water.*—There appears to be a divided opinion as to the utility of this plan of removal of fæcal matter. Some eminent authorities upholding this as the best and most efficacious mode of removal, as well as the least injurious to health. Others again equally eminent hold it to be one of the worst, and that it ought to give way to some better system in which there is no possibility of decomposition of fæcal matter, alleging with some show of truth that the air of houses is contaminated to an injurious extent, if there should be the least defect in the apparatus or traps, and also that these are very apt to get deranged. Some have even gone so far as to

say that even with the best arranged closets and traps, it is impossible to prevent injurious effects arising from sewer-gases.

Dr. Parkes says, 'This is the cleanest, the readiest, the quickest, and in many cases the most inexpensive method of removing sewage. The water supplied for domestic purposes, and which has possibly been raised to some height by steam or horse power, gives at once a motive force at the cheapest rate; while as channels must necessarily be made for the conveyance away of the waste and dirty water which has been used for domestic purposes, they can be used with a little alteration for sewage also. It would be a waste of economy to allow this water to pass off without applying the force which has been accumulated in it for another purpose.'

'But if this is obvious, it is no less so that certain conditions of success must be present, without which this plan, so good in principle, may utterly fail. These conditions are, that there shall be a good supply of water, good sewers, and a proper outfall, and means of disposing of the sewage. If these conditions cannot be united, we ought not to disguise the fact that sewers may give rise to no inconsiderable dangers.'[1]

For well-constructed sewers Dr. Parkes gives the following essential points: 'At the place of connection with the houses they should be most solidly constructed (which is seldom the case), and should

[1] Opus cit. p. 343.

be so arranged that if reflux of gas ever takes place, it may not penetrate into the house. At the point of connection there should not only be a trap, but an opening just beyond, with a ventilating valve, to save the trap from the pressure of the sewer gas.'

Sewers should be well supplied with water, as they require to be well flushed from time to time, and it is questionable whether rain-water should be allowed into sewers or not; it washes them, but at the same time carries débris, sand, and gravel from the roads which might stop them, and storm waters may burst the sewers, or overflowing them, may force back the sewage.

In the construction of water-closets we must bear in mind who has to use them. The poorer classes do not pay sufficient attention to cleanliness in general, and therefore when any complicated arrangement is in force it is likely to end in failure. In Liverpool trough closets have been found to answer best, and in Leeds and Birkenhead tumbler closets have been constructed.

The simplest form of water-closet consists of a conical earthenware pan, with a syphon attached below, the end of which can be jointed with the house sewer, by junction pipes made for the purpose. A ventilating pipe should be inserted beyond the bend which holds the water; this should always open into the open air, especially avoiding any cistern which may supply the closet with water, or perhaps supply water used for domestic purposes. No special water supply is required for this simple closet, as the house-

slops may be poured down, and will be found sufficient.

It is better to have the supply of water to closets self-acting, the apparatus being attached to the seat, if it is supplied in boxes for the purpose; they should be capable of holding a couple of gallons, with a division so that each compartment will contain one gallon: this can be used for flushing the pan, and will prevent any waste of water.

For a number of people in a court or row of houses trough-closets may be used. Instead of a pan for each a trough of slate or iron is placed underneath the seats, with an inclination towards one end, this end communicating with a drain leading into the sewer. A plug should be placed in this which is easily removed by the person who has access to the closet. These closets should be in charge of a proper person (scavenger) who has access to the space behind, removes the plug and flushes the trough, letting in more water after doing so; this ought to be done daily.

The tumbler water-closet is another form of closet suitable for a collection of people. The closets are the same as the last mentioned, with a permanent opening with the sewer, and the water drops into a swinging basin which, as soon as it is filled to a certain point, tips over and empties itself.

The next question that arises is what are we to do with the sewage matter? How are we to dispose of it? We shall see that there are as many plans for the treatment and disposal of sewage as there are for its removal.

Whether the water-carriage system of removal will eventually give way to the pneumatic system it is difficult to say, but at present for towns and large villages this system is the cheapest and cleanest that can be adopted, but to make it successful we must find some means of disposing of the sewage matter without giving rise to a nuisance, or polluting our water courses. The early sanitary reformers, in their eagerness to remove these offensive matters, did so without considering how it was to be disposed of, but turning it into our rivers, gave rise to evils equally serious in their results.

When sewage matter is poured out into the sea, no nuisance is likely to arise provided the outfall is at a sufficient distance from, and currents do not set towards the town, but should it be poured out close to the town over the beach, a nuisance is sure to arise, and be a source of danger to the inhabitants. Where again the sewage is poured into rivers, banks of sewage mud are likely to be formed, and when dry give rise to offensive exhalations, and also pollute the water itself, which is certainly a serious matter if other towns or villages derive their water-supply from it, below this point, or in the case of a tidal river the sewage is carried back into the town, or even to a point above where it is poured into it.

There can be no doubt that to pollute our rivers and streams with sewage matters is injurious, especially where the water-supply for some other district is obtained from the river : it is a mistaken idea to pollute a stream and then render the water innocuous by chemical agents.

It has, however, been argued that organic matters are so speedily oxidised when brought in contact with the oxygen dissolved in river water, that they are rendered harmless, even after a flow of a short distance. Dr. Frankland, however, has said after numerous experiments on the subject, that 'there is no river in the United Kingdom long enough to effect the destruction of sewage by oxidation.'[1]

Treatment of Sewage.—We may classify the treatment of sewage under three heads, viz: 1, Precipitation, 2, Irrigation, and 3, Filtration.

I. *Precipitation.*—We have several methods of precipitation, all of which have for their object the purification of sewage by the addition of chemical agents. The dissolved matters being thus precipitated can therefore be separated along with the suspended matters, while the effluent water is supposed to be sufficiently pure to flow into our rivers.

(*a*) *A B C process* invented by Mr. Sellar. By this process it is maintained that 'the effluent may be made entirely unobjectionable.' The early efforts of the company were not successful in accomplishing this desirable result, but some recent and extended trials appear to warrant a further consideration of the process before pronouncing a final judgment. Much has been done since the report of the 'Rivers Pollution Commission,' at Leamington, where the works were badly constructed for another system, and too small for the purpose: failure under such circumstances might have been anticipated.

[1] Vide Hart's 'Manual,' p. 241.

(*b*) *Bird's Process.*—This consists in the addition of crude sulphate of alumina and subsequent filtration through coke. This plan was tried at Cheltenham, but had to be abandoned.

(*c*) *Hill's Process.*—A mixture of lime, tar, chloride of magnesia calcined, and some other substance is added. This process is carried on at Wimbledon.

(*d*) *Holden's Process.*—Lime, coal-dust, sulphate of iron and clay is added to the sewage; but it fails to remove the nitrogenous matters in solution, and is therefore of little value.

(*e*) *Precipitation of Lime Process.*—Milk of lime is mixed with the sewage at the outfall works, and a precipitate takes place which may be sold as manure, or even made into bricks. The effluent water, which is in a milky condition, contains a great proportion of fertilising material and putrescible matter. It has been tried at Tottenham, Blackburn, and Leicester, but the Rivers Pollution Commissioners pronounce it a failure.

(*f*) *The Phosphate Process* has been tried at Tottenham; to the sewage a solution of native phosphate of alumina dissolved in sulphuric or hydrochloric acid, and diluted with water, is added. This method is only proposed as a preliminary to irrigation.

(*g*) *Dr. Anderson's Process* consists in adding an impure sulphate of alumina to the sewer-water in the tank; the sulphate is procured by dissolving aluminous shale in sulphuric acid.

(*h*) *Whitthread's Process* consists in adding to the sewage milk of lime and alum salt; the precipitation is very rapid, and the super-natant fluid is clear, but the process has not been pronounced satisfactory.

(*i*) *Scott's Process.*—This process, invented by General Scott, consists in adding to the sewage in the sewers in the town a mixture of clay and lime. It is found that this effectually cleanses the sewers and deodorises the sewage; in the tanks a precipitate forms, containing a large proportion of clay and lime. The precipitate is then removed to be dried and burnt in the kilns, and is thus converted into cement; the effluent water is then fit to be applied to land in the process of irrigation.

II. *Irrigation.*—This process purifies the sewage thoroughly, utilises the manure, and may be carried on without injury to health or creating a nuisance. For its successful employment the following rules have been collated by Dr. Wilson, in his 'Manual of Hygiene,' pp. 264, 265:—

(1) 'That the acreage be sufficient: this will depend in great measure on the looseness and porosity of the soil; hence to lay down as a rule that one acre should be allowed for every hundred inhabitants, which is the estimate usually given by engineers, is manifestly illogical.

(2) 'The land to be irrigated must be drained, and stiff clayey soils broken up and mixed with ashes, sand, or lime.

(3) 'The surface must be irrigated on the intermittent system, to insure sufficient aëration of the soil.

(4) 'The ground should be laid out in broad ridges and furrows, the sewage being conveyed along the tops of the ridges in open carriers, and made to flow gently down the slopes by inserting temporary sluices in regular succession and at regular intervals. At Breton's farm, near Romford, rented by Mr. Hope, the breadth of the ridge is thirty feet, giving a slope of fifteen feet on either side of the carriers.

(5) 'There must be a rotation of crops, such as rye-grass, peas, maize, different roots, cabbages, &c.

(6) 'The sewage should be delivered in a fresh state, and freed from the greater portion of its suspended matters. This may be effected either by precipitation, filtration, or screening.'

The irrigation system of treatment of sewage must not be on the saturation principle, as the sewage must pass through the soil before it is purified, for if we depend on vegetation alone to oxidise the organic matters we shall be disappointed by a failure of the plan.

Numerous objections have been urged against this system of sewage irrigation, many of which are mere assertions without good grounds for substantiating them; such as the propagation of enteric fever by the milk from cows fed on sewage grass, and also the production of cattle diseases, such as cattle plague, &c.

In a comment on a report on enteric at Ecton and its relations with the sewage, by Dr. Buchanan, we find the following remarks in the 'Practitioner,' vol. x. p. 327: 'This report furnishes important

additional evidence to the effect, first, that no unwholesomeness appears to attach to labour on sewage-irrigated land; and secondly, that there is an occasional source of danger to health from such land which needs to be carefully guarded against—namely, the danger of water in the outflow channel of the irrigated land, when an open channel, being mistaken for ordinary brook water and used for drinking.

III. *Filtration.*—Through the experiments of Dr. Frankland, the filtration of sewage has been brought prominently into notice, the results of these experiments being published in the first report of the Rivers Pollution Commissioners (1870). It is shown from the results of these experiments that if sewage be passed downwards through beds of sand or soil, it is satisfactorily purified if the process be allowed to go on intermittently, so as to give time for aëration of the filter-beds.

It was also found that nitrogen which existed in the original sewage, either in organic matter or as ammonia, was found in the effluent water in the form of nitrates and nitrites, oxidation having taken place during its passage through the filter. Upward filtration through the same filters does not cause the same purification. At Methyr Tydfil this plan has been adopted on a large scale, twenty acres of land having been laid out in square beds, and pipe-drained at the depth of about $7\frac{1}{2}$ feet, so as to be used as filtering beds.

This system of *intermittent downward filtration*, as adopted at Methyr Tydfil, appears to be an

effective means of purifying sewage. 'It consists' (according to the fourth report of the British Association Sewage Committee, read at Brighton in 1872) 'of a deep bed of gravel (probably the former bed of the river Taff, which is embanked upon the east side, and is raised above the valley), composed of rounded pebble of the old red sandstone and coal measure formations, interspersed with some loam and beds of sand, forming an extremely porous deposit, and having a vegetable mould on the surface.' . . . . 'The sewage, before being turned on to the filtering-bed, is screened through a bed of slag, which arrests the coarser matters. It is applied to the land intermittently, for the area being divided into four plots or beds, it is turned on to each one for six hours at a time, leaving an interval of eighteen hours for rest. The surface land was cultivated to a depth of from sixteen to eighteen inches, and laid up in ridges, in order that the sewage might run down the furrows, while the ridges were planted with cabbages and other vegetables.' Thus it will be seen that the surface of the filtering-bed has been turned into a sewage farm.[1]

Mr. J. Bailey Denton, in a paper communicated to the National Association for the Promotion of Social Science, at the annual meeting at Glasgow, speaks highly of this process. He had previously demonstrated its utility at the International Exhibition, South Kensington.[2] He says, 'London sewage

[1] Vide 'Hart's Manual,' p. 294.

[2] Vide 'Public Health,' vol. ii. p. 342.

was delivered daily to the several exhibits of sewage treatment by the authorities of the International Exhibition, independently of the exhibitors. The quantity delivered to the author for treatment by intermittent downward filtration was twenty-five gallons daily (except Sundays). This sewage was distributed each day over the surface of three cubic yards of natural soil of a free description. Having filtered through the soil, it was discharged as a clear effluent by a small outflow, increased and diminished in volume as the sewage was applied. Owing to the necessarily limited character of the exhibit, it was anticipated that the purification of the sewage by the soil would become less efficient the longer it was used.

'It will be seen, however, from the following analysis, that the contrary effect has been the result.

'The sewage was first applied to the soil on June 23, 1874, and the application was daily continued from that date, Sundays excepted. On June 30, seven days after the first application, a sample of the effluent water was collected, and sent to Dr. Benjamin Paul, F.C.S., for analysis, who forwarded to the author the following results:—

Free ammonia	·009 in 100,000 parts
Organic nitrogen	·049 „ „

On August 10, forty-eight days after the first application of the sewage to the soil, a second sample was collected and analysed by the same

eminent chemist, when he reported the following results, viz.:—

Free ammonia	·006 in 100,000 parts
Organic nitrogen	·038 „ „

On September 14, eighty-three days after commencement, a third sample of the effluent was taken, and of it Dr. Paul said that it was "even better than that of the 10th of August." This is shown by the following figures:—

Free ammonia	·002 in 100,000 parts
Organic nitrogen	·022 „ „

In order that these figures may be compared with the standards of purity recommended by the Rivers Pollution Commissioners, it may be stated that, disregarding free ammonia as of comparatively little importance, they considered that any liquid containing more than ·3 part of organic nitrogen in 100,000 parts should be deemed inadmissible into rivers.

'In supplies of drinking-water to the metropolis by the eight companies, the mean amount of organic nitrogen appears to be ·028 in 100,000 parts.

'The improvement in the condition of the effluent water, which these figures of Dr. Paul show, is doubtless due in a great measure to the means taken to deliver and distribute the sewage on the soil with regularity, each cubic yard of soil receiving precisely the eight gallons of sewage it is designed to absorb, cleanse, and discharge. This is effected by the use of the "Self-acting Sewage Regulator," the

object of which contrivance is to apportion and deliver the precise quantity of sewage which land, prepared for irrigation or for intermittent filtration, is designed to utilise and cleanse, and this is done independently of all supervision and of the outflow of the sewers contributing the sewage, which may at one time be extremely copious, and at another little more than a dribble.

'The irregularity of discharge attending the sewage of small towns, villages, mansions, and all kinds of large establishments, is found to be the great difficulty in dealing with these communities. Besides overcoming this evil, and thereby reducing the comparatively heavy cost of applying small quantities of sewage to land, the Regulator secures with certainty that intermittency of application which is so essential to purification; moreover, the action of the Regulator is automatic, and requires no attendant at night, or on a Sunday. The sewage as it is discharged from the town, village, or mansion flows into a tank of a capacity to hold the quantity of sewage it is desired to deliver to a certain area of land at one time. This tank is provided with a syphon or self-acting means of discharge, and directly the liquid rises to a given level the outlet comes into action, and the liquid is at once discharged. When the tank is emptied the discharge ceases, and the sewage commences to fill the tank again, or another tank, as found desirable, slowly or quickly, according to the rate of influx.'

In the case of villages of sufficient size, and

where a proper and efficient water-supply can be had without much difficulty, the system for the removal of excremental matters should be that by water, the sewage matters being treated in the manner adopted at Methyr Tydfil, and using Mr. Denton's Self-acting Sewage Regulator; the effluent water would then be rendered sufficiently pure to enter our rivers with advantage in many cases.

A combination of plans might be adopted, for if Mr. Scott's treatment of sewage in the sewers was carried out, and the effluent water underwent the process of downward intermittent filtration, it would be rendered still more pure.

The quantity of land for the purposes of irrigation need not be very great, therefore no objection can be raised in reference to the purchase of land where it is costly. Mr. Bailey Denton says on this subject:—'Intermittent downward filtration will be found equally valuable, whether adopted by itself on a limited area of land, for the primary object of *purification*, or in combination with surface irrigation on an extended area, as a means of securing the best return from the *utilisation* of sewage. The value of the process in the former case cannot be over-estimated, as it enables sanitary authorities to purify their sewage up to the standards recommended by the Rivers Pollution Commissioners, by the use of just as much land as they can get, if the quantity be not less than one acre to 1,000 persons, and of gaining some return in the shape of crops at the same time. When adopted in combination with irrigation, intermittent downward filtration becomes

the "safety-valve" of sewage farming, inasmuch as where a certain quantity of land is specially prepared for intermittent filtration, the farmer need not take sewage on the irrigated land when he does not want it, nor when the cost of application will exceed the benefit derived from it.'

An illustration of the cost of adopting intermittent downward filtration in a case where the land was very costly, and the works of drainage and surface preparation, including carriers, &c., for distribution, expensive too, may serve to show how small will be the rate charged on a district for such mode of disposal, when calculated upon the population and rateable value of the district contributing the sewage, which is the only proper way of considering the subject. In comparing the cost of intermittent downward filtration with that of any other process, it must not be regarded as an acreage outlay, but as one in which the total expenditure, with its profit or loss, must be fairly considered in relation to the ratepayers' interests.

In the case of a district containing a population of 15,000, with a rateable value amounting to 45,000, and requiring fifteen acres of land to purify the sewage discharged from the district, the costs may reach the following items:—

Land	£3,000
Underdrainage, preparation of surface, carrier for distribution chambers, &c. .	2,000
	£5,000

The charge on the district necessary to repay this sum with interest, in fifty years, would amount to 225*l.* per annum.

In many rural districts the water-carriage system of removal of sewage cannot be adopted, owing to the insufficient water-supply. In this case some form of the dry method must be adopted, the management and arrangements of which should be wholly under the control of the sanitary authority, who must see it properly carried out.

In scattered villages and at farmhouses the dry earth-closet (under supervision) will answer admirably, and instead of earth fine ashes might be used. Some simple plan by which the cinders can be separated from the fine ash, and this made to cover the excreta, might be adopted. The present privies now in use by a small outlay could be converted into dry earth-closets, which will answer well. Dr. Carpenter, in an article on Village Sanitation, in 'Public Health Journal' (vol. iii. p. 269), gives an illustration of Moser's dry closets, which can be substituted for 'cesspool accommodation,' and they have answered remarkably well at Waddon, a village near Croydon.

CHAPTER VII.

NECESSITY OF AN EFFECTIVE SYSTEM OF LOCAL GOVERNMENT IN RURAL DISTRICTS—SIMPLIFICATION OF SANITARY AREAS AND AUTHORITIES NOT YET ACCOMPLISHED—OBSTACLES ON THE PART OF RURAL AUTHORITIES TO DEPARTMENTAL INTERFERENCE—PRIMARY CONDITIONS OF SANITARY REFORM—SPECIMEN CODE OF BYE-LAWS.

It has been reserved for this, the iron age of political economy, to affirm and develop the doctrine that the moral nature varies as the physical condition of mankind; that matter and mind are correlative forces mutually dependent, under a reign of law; and that the conservation of the public health is essential to the maintenance of a sound public spirit, and the real foundation of national prosperity.

Nations sink into decay unless the people retain the power of transmitting their original vigour unimpaired to their posterity, and in this respect each contagious and endemic disease which has gained a footing in the country is an enemy within the gates, and may be regarded as so much loss of national strength and energy. Nevertheless, the first efforts of legislation with regard to the public health were received with contemptuous indifference, and the disquieted spirits who foreboded evil from reckless pol-

lution of rivers were regarded as disciples of 'Solomon Eagle' proclaiming the wrath to come!

Those who believe in the dispensations of an all-merciful Providence will discern in the recurrence of plague and pestilence, murrain and cholera, periodic revelations of the Almighty to his creatures, and read a solemn 'writing on the wall' in the condition of things around them. We have indeed reached a crisis in our sanitary history, and the rivers of England have been converted into sewers. The Thames is filled 'with moving organisms' and 'matted fungoid growths.' The Aire and Calder, Irwell and Tame, are rivers of black desolation. On every side are polluted water-courses, poisoned wells, rivers dyed with the refuse of factories, or yellow with the waste of industrial processes. In Durham,[1] inflammable refuse has literally set the streams on fire; and farther north, the banks of the once 'crystal Teviot' are strewn with dying fish. Contamination has reached the sequestered dells of Surrey, and Yorkshire dales bring filth, in lieu of trout, as tribute to the larger streams.

Five consecutive reports of the Rivers Pollution Commissioners have sounded the tocsin of alarm, and the public sentiment is ripe for the reception of a new creed—'*sanitas sanitatis, omnia sanitas!*'[2]

The knot is worthy of a great minister, of a party possessing both place and power,[3] and there will be need of fortitude, discretion, and forbearance in order

[1] *Vide* speech of Lord Salisbury, House of Lords, May 1875.

[2] Mr. Disraeli at Glasgow, 1874.

[3] *Sit nodus vindice dignus.*

to achieve the end and purpose of recent legislation. As yet we are timorously treading over fresh ground, under the guidance of a new department, and in the fierce light and clamour of public impatience. Men require the instant solution of problems which had long lain hid in the pigeon-holes of officialism, or had been relegated to the cold shade of the Privy Council, and the vigour of our leaders scarcely keeps pace with the expectancy of the nation.

'*Simplification of areas and authorities*,' said Mr. Stansfield, 'was the object of the Act of 1872;' and he added that sanitary law can be effectually administered only by 'securing the intelligent co-operation of local representative bodies.'[1]

The theory is admirable, but the facts are against us. We have at present neither simplified areas nor authorities; and Diogenes with his lantern would search in vain to discover any trace of 'intelligent co-operation' among the frequent townships, hamlets, chapelries, lighting and paving districts, liberties, and other 'ancient and unobtrusive' communities, which are interspersed without sympathy and cohesion throughout the country.

In the Public Health Act of 1872 it is enacted that the guardians of a rural Union shall form the rural sanitary authority of such district; but in many Unions[2] two-thirds of their area is under the jurisdiction of local boards or special commissioners;

[1] *Vide* Mr. Stansfield's address at Halifax, January 11, 1875.

[2] *Exempli gratiâ*—Brentford, Kingston, Edmonton Unions; *cum multis aliis.*

and hence it is that the rural authority is confined to a petty village, which is overwhelmed with administrative energy. In others, the burden has been cast upon incompetent and unwilling shoulders, and the guardians have been unconscious benefactors to the community by their reluctance to take any action whatsoever. In the case of towns invested with municipal rights—reformed or unreformed—the sanitary authority of the corporations is restricted within the too narrow limits of the borough boundaries.

Adjacent jurisdictions hem them in on every side, and around each historic centre, or 'rotten relic of antiquity' (as it has been of late irreverently styled), cluster villages and hamlets, affiliated perchance for electoral purposes, but excluded from the benefits of municipal administration and sanitary supervision. In such as these the only authority is the Vicar and the ratepayers in vestry assembled; but we look in vain for either intelligence or co-operation in these discordant bodies, which are disqualified both by their constitution and temperament for the work of sanitary reform.

There are yet ninety-six ancient[1] corporations in the kingdom unswept by the Municipal Reform Act, which have lately undergone a process of 'cruel vivisection' on the floor of the House of Commons; but besides these, the country is overlaid with a mosaic of heterogeneous jurisdictions, liberties, domains-ecclesiastical,[2] surviving the abbots which they

[1] Sir C. Dilke in the House of Commons, June, 1875.

[2] *Ex. gr.*, the Liberty of St. Albans.

once protected, local boards, improvement commissioners, special drainage districts, jumbled together with courts baron, courts leet, marches, manors, and forest courts; effete relics of feudalism, or peradventure spasmodic efforts on the part of the Legislature to cope with the requirements of particular districts, where there has been a sudden outbreak of popular clamour or infectious fever; and among these it would be folly to expect 'an intelligent co-operation,' or any combination for wider purposes than the accomplishment of purely local objects. Ever and anon quaint institutions hitherto unsuspected crop up on the surface, disclosing their inward rottenness by a species of fungoid vitality, which infests the ground, and cumbers the progress of the sanitary reformer.

Moreover, among the more enlightened section of the rural population, we can hardly anticipate an intelligent compliance with the objects of the Legislature until the string of enactments, termed 'the Sanitary Acts,' have been further simplified, and rendered harmonious by codification.

Even the practised student is bewildered by the maze of sections and subsections dovetailing in the letter, but not in the spirit—in juxtaposition, but without reciprocal inter-dependence—mechanically, not chemically united.

The result is veritable chaos. There may be latent wisdom in a multitude of councils, but they lack uniformity of design and the strength of combined action.

Take Kingston-upon-Thames, for example: we find there, within a limited area, three independent authorities—viz., the Borough Corporation, the Surbiton Commissioners, and the New Malden Sanitary Board. Even these three do not exhaust the whole of that distracted parish, which to some extent is within the jurisdiction of the rural sanitary authority of the Kingston Poor-Law Union.

Simplified area forsooth! 'Intelligent co-operation of local bodies' is illustrated there by the desire of the corporation, on the one hand, to purify their sewage-waters and discharge them into the Thames; and on the other, by the proposal of the surrounding jurisdictions to further divert the course of that river by a grand arterial sewer, whose dimensions and cost will rival the Cloaca Maxima of Rome!

L'union fait la force—but the maxim has not yet reached the pleasant glades of Surrey.

Richmond-on-Thames is a notable instance of supineness and inertia under local difficulties; confronted on every side by Royal Rangers, Crown Land Commissioners, River Conservators (clamouring for the cessation of a flagrant nuisance), Royal Domains, and jealous landlords, the select vestry is at its wits' end—a sight to move compassion of both gods and men!

Embarrassed and distraught by intestine conflicts, they appeal in vain to engineers and experts; and whilst striving to find an outfall for their sewage, and a means of escape from the toils of the enemy, ignore altogether the broad river at their feet—the

true and natural outfall—*under proper sanitary restrictions*, for themselves and their neighbours.

Hertford comprises six parishes, of which the most important is wholly within the borough jurisdiction; the remaining five are partly within, partly without that jurisdiction: and the town is thus, for sanitary purposes, dismembered and hampered by divided allegiance.

The borough struggles gallantly with its sewage difficulties; but one comprehensive system, embracing the united area, would have secured economy of first outlay, and a much diminished annual expenditure.

St. Albans is the victim of a still more anomalous conflict of local interests; and it is hoped that the advent of a bishop may serve to bring about a fusion of parties, and inculcate the duties of man towards his neighbour in their widest sense.

On the other hand, Bedford affords a distinguished precedent of the benefits of union and simplification. All its parishes are united into one sanitary area, under one jurisdiction; and an effective system of sewage utilisation, with a remarkable improvement in the sanitary condition of the whole district, is the logical and already accomplished result.

It would be easy to multiply examples in the metropolitan counties, but those cited will suffice to establish our first proposition—viz., 'that we have yet to provide a complete system of local government, capable of dealing effectually with sanitary organisation in rural districts.'

In the large majority of instances the inhabitants have made no sign; '*Quieta non movere*' is their motto and rule of conduct; 'to let things alone' has the recommendation of a great statesman[1] to support it; but it is a policy which, in country villages, implies stagnant pools and pestilent ditches, and fixes upon the population the inevitable stamp of physical and moral degradation.

This leads us, by a natural sequence, to the consideration of our second preliminary difficulty—viz., that 'provincial and centrifugal spirit' (to adopt the language of a great writer[2]), which resents the intrusion of departmental theories, or official experts, in matters of local administration.

This spirit is the offspring of insular independence and ingrained in the national temper. It displays a certain jealousy of coercion, which is personified in the immobility of the sturdy British yeoman, and has been conciliated rather than subdued by generations of sagacious statesmen.

It permeates the atmosphere of Parliament, embodied in that intractable element which, under the cuckoo-cry of political consistency, will let loose a deluge rather than yield a hobby; but it is rampant in the local board-room.

The incidence of the rates, the extravagance of Poor Law Unions, and exemptions in favour of real property, are the familiar topics and staple of its ordinary life; but sanitary reform, and the visits

[1] Lord Melbourne.

[2] Mr. J. Lothrop Motley, in his life of 'Olden Barnevelt.'

of the Government Inspector, become its especial irritant and bugbear.

Under the inspiration of this spirit, and filled with vague alarm for the safety of the constitution, the editor of the 'Local Gazette' dogmatically proclaims—'that the municipal council chamber and the local vestry-room are the nursery-ground of Parliamentary liberty!'

'Centralisation and bureaucracy cannot coexist with local self-government,' declares the president of the Ratepayers' Association. 'We are a loyal and a law-abiding people; but it is easy to see where the province of Imperial Government begins and ends. If, for example, the Government had undertaken the task of solving the grand enigma of our times—viz., the disposal of sewage; if, by employment of those scientific agencies which Government alone can command, it had investigated the relative merits of irrigation, precipitation, and filtration, instead of abandoning a momentous question to the zeal and inadequate resources of the British Association; if Parliamentary grants and official aid were forthcoming even now, at this eleventh hour, we farmers and factory owners should recognise in these and similar measures the true functions and purpose of superior Government This is the special field and scope of imperial intervention, where individual enterprise is weak and futile; and to what nobler end, we ask, in what graver domestic perplexity, can the national resources be applied? We have had enough of

inspectors, and commissioners of enquiry, of *precepts* and *provisional orders*, sanitary surveys, and reports. Where the Government meddles in local matters it will always muddle; and this incessant official interference only serves to thwart the energies and instincts of the local authorities.'

We confess our sympathy with much of this impatient protestation, but imperial necessities require imperial measures; and at this conjuncture the impulse which leads to action must come from above, even at the risk of imposing for the nonce that paternal system of supervision which, when prolonged, is fatal to the development of a sound public opinion. It is only for awhile—until the machinery of local government has been carried over the dead-centre of resistance, and even the most stubborn are convinced that they must yield at last.

'Why disturb the repose of this secluded spot?' ask the rude fathers of the hamlet. 'My father has lived on that black ditch nigh seventy years, and is hale and hearty now! Many a time I have drunk of it, and would do so again if I were thirsty!' The interlocutor is the landlord of a row of small tenements, and has compounded for the rates; another sixpence in the pound for health and cleanliness will break his back, and the prospect of still further imposts stares him in the face, stirring his patriotic blood within him. All sewage systems alike are 'anathema' to him; and the bare mention of the necessity of a local board is to his senses a scarlet rag!

People are ever found to say, 'I love stinks! they are not unwholesome—in fact, do *me* good! That water I am ready to drink or bathe in it!' And thus it comes to pass that every effort to purify the wells and watercourses of the district is thwarted by an universal *genius loci*, stolid, inert, and pertinacious, which will never be effectually eliminated until the functions of local government have been elevated and expanded by the institution of county administrative boards, and the creation of enlarged sanitary areas. We may shape them on the model of the 'Conseils Generaux' of France, or the provincial estates of Holland, so that the control of ways and means would remain with the people through their representatives chosen in each subdivision of the county, and charged with the special mandate of declaring the requirements and conditions of each sanitary district.

Many will remember the Sewage Parliament which, self-constituted and improvised under the presidency of Sir H. Peek, assembled at Kingston-upon-Thames on January 31, 1872, to consider the vast project of Mr. Bazalgette for draining the upper Thames valley.[1]

Earnest men assembled there to discuss a subject of vital import to the common welfare; but the want of organisation and of authority to pledge the districts which they severally represented rendered their deliberations nugatory; and it was manifest

[1] Plan for purifying the Thames from the metropolis to Windsor, by Sir J. W. Bazalgette, C.B., C.E.

at the meeting that combined action would be frustrated by local jealousies and heartburnings, even in the presence of so grave a calamity as the threatened contamination of their common water-supply. In this dilemma nothing was done, and that 'intelligent co-operation,' of which Mr. Stansfield speaks, has become a phantom of the imagination.

To remedy this state of things, and pave the way for that harmonious action which gives a sense of strength and compactness to local efforts, we advocate the immediate constitution of county or watershed boards. We may enlist in this wise the co-operation of many practical and enlightened men, who have hitherto held themselves aloof through dread of encountering the turmoil of parochial politics; and we shall have revivified the whole range of local authority by the importation of elements which will give to it wider scope and dignity.

There will be room and a fair field even for those 'village Hampdens' who now waste their energies in petty squabbles; and a ready means of political education for all classes of the people above the narrow platform of local passions.

We will now proceed to enumerate the three primary conditions of public health upon which sanitary progress is based, and by which alone it will be secured.

These three primary conditions are—

1. Pure air.
2. Pure earth.
3. Pure water.

Purity implies cleanness; and uncleanness has been happily defined as 'matter out of place.'

In this short definition lies a truth, which is the keystone of the arch of sanitary science—viz., that everything in the economy of nature has its place, purpose, and value.

In every operation of nature and every function of life a certain residuum is left over and above that which in the process is assimilated, or converted.

Man in his blindness calls it 'waste.' It is not waste, but wealth, if rightly used with thrift and purpose. Abuse may make it foul, but only shallow prejudice would think of it as evil.

'Waste not, want not,' should be a household word engraved on every cottage-door, that all alike may learn how great economy there is in little things. How many English villages, in which the struggle for existence is ever hard and bitter, neglect this homely truth!

Look at that tainted watercourse! There is matter out of place—those foul dilapidated styes, broken stalls, and reeking dung-pits, where wealth and plenty run to waste, infecting earth and air! The sanitary inspector is abroad. Let him then look to it, and take a lesson from the trim villages of Belgium, or the dairy stalls of cleanly Holland. There he will see refuse in its place, not out of it, preserved with thrift for its true purpose; and if we would have health and purity within and around our dwellings we should go and do likewise.

There will be need of method and organisation,

perhaps of coercion at the outset, but the force of habit and example will prevail, and the instincts of a law-abiding people will overcome all obstacles, and induce compliance.

The earth itself performs the kindly office, and both conceals and converts to our advantage that organic decay which results from the functions of every form of life. Moreover, our senses teach us the necessity of removing refuse, which, when exposed to atmospheric influences, becomes disintegrated. Decomposition then sets free its gaseous products. These in their turn infect the air, and our sense of smell at once detects the waste and violation of the harmony of nature.

There are abundant resources at every village door in this deodorising power of common earth, and where there is not space in garden-plot or field to utilise it, every community should provide for the removal of its refuse to a common depôt, at the expense of, and for the benefit of, all.

The waste of house and stable, ashpit, and midden should be carried thither day by day, and defecated by throwing over it a layer of dry absorbent soil; until in due time it be restored to fertilise and replenish the earth.[1]

There are none other obstacles to this simple sanitary precaution than indolence and ignorance. Moreover, there is palpable economy in a diminished

[1] *Vide* 11 & 12 Vict., c. 63, sec. lvi., confirmed by 21 & 22 Vict., c. 98, sec. xxxii.

death-rate, and the scavenger's cart costs far less than the fever ward of the workhouse infirmary.

There is, however, a far wider mischief, not always at our doors, but flowing we know not whither. When it returns to us in the guise of pythogenic fever, or diphtheria, perchance of national pestilence, we marvel at the Almighty dispensation, and straightway on our knees implore a miracle, with fear and trembling.

It is a monument of human recklessness, this burning question of our day; which dwarfs all other topics into comparative insignificance, and is familiarly known as the 'pollution of rivers.'

The development of industrial enterprise on every side, and the waste of mines and factories, are potent causes of this pollution; but in many quarters it is mainly due to that luxurious contrivance, the domestic water-closet. Every town and every hamlet feels the baneful effects of a process which employs wholesome water as a vehicle for the removal of filth, and infects a thousand gallons of the precious element for each gallon of excreta thus removed.

It would indeed be hard to conceive a system more wasteful, or in its widespread results more pernicious. When the diluted excrement is discharged into subterranean cesspools, it pollutes the soil by gradual infiltration; and where it flows through open drains and watercourses it infects the air by noisome exhalations, engenders disease, and contaminates the running waters.

Shallow minds conceive that they are rid of a nuisance when they have transferred it to their neighbours; but the universal outcry and want of wholesome water for the food of the people and the requirements of national industries, have rudely dispelled the delusion, and recalled even the most obdurate to a sense of public decency.

'There is no town which might not, with reasonable care and at a moderate cost, greatly mitigate the existing evils,' states the Report of the Commissioners on Town Sewage;[1] and if this domestic appliance be indispensable to modern luxury, and must be retained at all hazards, a question will arise, of immeasurable importance to the future, how far any town can be permitted to discharge its sewage-waters, even into a tidal river, until they have been cleansed from all polluting qualities and rendered comparatively innocuous.

The metropolis itself has yet to answer for the evil it has done by transmitting millions of tons of sewage sludge into a navigable reach of the Thames. It would, however, be a fatuous course to purify our running waters by an inductive process, commencing at the mouth and working upwards, while leaving untouched the source of evil at the river-head.

Each babbling brook and upland valley sends down its quota to swell the torrent of pollution. It is there that we must check the wanton mischief, and absolutely prohibit, without regard to vested

[1] *Vide* Report of 1861.

interests or ancient usage, the passage of any polluting matters into the streams and watercourses.

There is yet another insidious contrivance, more fatal even than foul drains and ditches—the neglected cesspool.

In many a village garden you will find cesspool and well side by side in fatal contiguity, environed by privies, styes, and dung-pits. In yonder close and fetid court the ground is honeycombed with dilapidated cesspools or broken drains, and poison steals through the porous soil with sure and certain course.

The watercourse hard by is far too foul even for domestic ablutions; water fit for the cooking pot must be purchased at the cottage door; and personal cleanliness becomes a Sabbath luxury, for lack of means during the week to wash withal.

The dwellers in that noisome quarter have perished silently and by stealth. The agents of the local burial society regard it with misgivings; yet nothing is done to purge the mischief, for the sympathies of the local vestry are with the proprietors of these rookeries, and the people are too poor to help themselves. But the pestilence which walketh in darkness comes at last, and panic reigns throughout the village!

A Government inspector comes down in haste, to hold an inquest upon the epidemic; landlords tremble for their rents, and tenants for their lives! There is a long report, '*verbosa et grandis epistola*;' it is the old, old story—diphtheria, or typhoid fever, from well-poisoning.

Forthwith the well is closed by superior authority, and their only source of water cut off from the people.

In the meantime a similar process of infiltration, pollution, pestilence, panic, and enquiry is being matured in the adjoining hamlet, and will be perpetually reproduced, until the long-promised sanitary reforms come to the birth and are a living reality, instead of 'the figment of an exclusively scientific conception.'

The 'sewage farm' is deemed by many eminent authorities to be the true sanitary panacea; but however great may be the purifying properties of soil, the remedy is impracticable in populous districts for lack of land whereon to test it by actual experiment.

Whether 'sewage farming' can ever become profitable depends upon a concurrence of circumstances and conditions which have never yet been vouchsafed to us; wherever it is attempted in rural districts it will be necessary to group towns and villages together, and combine them in one sanitary area.

Such combination implies a far wider basis than mere parochial subdivisions, and should have reference to river-basins and their watersheds. It will be futile to palter with the subject by partial efforts. We require large and comprehensive measures, and must pray the aid of that rare genius which has been defined as an 'infinite capacity for taking trouble.'

In the programme of this treatise we are invited

to suggest the best means of obtaining health, purity, and cleanliness, 'under the most varying circumstances,' and we have already shown the paramount importance of keeping 'matter in its place,' poison from the wells, and sewage from the running waters.

The method of treatment and the standard of purity will vary according to local circumstances. With regard to effluent waters, for instance, the standard prescribed for the town of *Gravesend* may be lower than that required for *Reading* or *Windsor*; and in a tidal river a measure of impurity can be tolerated which would be dangerous above the intake of any waterworks. It has never been contended that chemical precipitation will render sewage waters absolutely pure, but by the use of intermittent filter-beds in combination, where a supplemental process may be deemed necessary, polluting matters can be arrested and oxydised, and the effluent cleansed of all organic impurities. For all ordinary cases a system of chemical precipitation will suffice, and when the suspended matters are thus retained, and fish can live, and cattle will drink of the waters, we shall at least have achieved a measure of sanitary success, at a cost per head of the population within the modest resources of rural districts.[1]

The daily growth of towns and population upon the banks of rivers, like the Thames and Tyne, points to the importance of these natural outfalls available at our doors. It is, however, folly and supineness to

[1] *Vide* Report of Royal Commission on Sewage of Towns, 1861.

make them common sewers, when by sanitary precautions they can be preserved to us bright and wholesome rivers.

The river bank must be, by law of gravitation, the most convenient outfall for every village sewer. Science can retain and defecate the noxious elements of the sewage,[1] while common sense protests against the absurdity of forcing water backwards by costly engines, things yet undreamt of in village philosophy. To be pumping night and day in perpetual conflict with nature, is like rolling the huge stone of Sisyphus up the mountain-side, only to recoil upon our heads in waste and ruin!

That a comparatively pure effluent is readily attainable by means of chemical precipitation is demonstrated by the elaborate report of Professor Keates on the native guano process at the Crossness pumping works. As the result of an exhaustive trial, he writes: 'The state of the effluent water was, on the whole, extremely good;' and again, 'I am of opinion that such water was in a fit state to be admitted into any ordinary river without producing a dangerous degree of pollution.'[2] The testimony of the learned Professor thus confutes the captious objector, and points to us a way of escape from a sanitary dead-lock. The commercial value of sewage residuum has been

[1] Experiments at Leeds. *Vide* 'Standard,' June 21, 1875.

[2] *Vide* Report on recent trials of the A B C process made by the Leeds Corporation, at Knostrop, by William Crookes, F.R.S., April 1876; also printed certificate of the Sewage Committee of that Corporation as to value of that process, February 29, 1876.

the subject of much acrimonious disputation; even celestial minds[1] have known the taint of jealousy and anger. On this subject it will suffice to state that science is at war with the opinions of practical men, and that the most reputed chemists[2] differ with each other, both as to the real value of the product and the correct rule to be adopted for estimating it.

Amid the turmoil of scientific discussion the modest enquirer is perplexed by volume after volume of recorded opinions, from farmers, gardeners, fruit-growers, and graziers, showing results of actual experiment and methodical trials altogether at variance with the conclusions of the Professors.[3] In some quarters it is even asserted that there is a margin of profit, and a ready sale for the commodity. If the price attainable is equal to the cost of production it is enough, and we have cut the Gordian knot even without a rate in aid.[4] The gross expenditure at Leeds is estimated at sixpence in the pound, an insignificant burden to the ratepayer, when contrasted with the multifarious imposts often levied upon other towns in order to pave the way for the march of sanitary improvement.

Notwithstanding the recorded opinions of the Prime Minister, and his proclamation that 'Sewage is king,' it is feared that there are divergencies of

[1] *Tantæne animis cœlestibus iræ!*

[2] *Vide* Liebig's Chemistry of Agriculture; also Crookes, F.R.S., on the Manurial Value of Sewage-sludge.

[3] Rivers Pollution Commissioners, Second Report, &c. &c.

[4] In Leeds, the cost of production is estimated at 24*s.* per ton. The value of the residuum, at 40*s.*

opinion within the precincts of Whitehall; that the vigour of each projected measure is emasculated by permissive clauses, or an overweening regard for the claims of usage and prescription; that precious time is wasted in further consideration, and the energy of subordinates palsied by a certain infirmity of purpose in high quarters.

Whilst asserting 'that the country is not ripe for a large coercive measure,' they confess 'that the present law is inadequate to cope with existing evils;' and that the nuisances of which complaint is made are of a very palpable and visible character.

Moreover, the area of these nuisances is constantly enlarging itself, and is no longer confined to the vicinity of manufacturing towns.

The enterprise of manufacturers has invaded the sanctity of secluded valleys far away from the haunts of men, fills the air with murky vapours, pollutes Arcadian streams with poisonous decoctions, and threatens soon to blight the pastures of the fairest portions of the kingdom.

While we have abundant evidence that there are in existence available means for the prevention of all such nuisances, partly by an extension of the Smoke and Alkali Acts, partly by improved constructions and the economisation of all manner of waste, it behoves the authorities in Whitehall to take the present tide of popular opinion at the flood, eschewing the laggard policy which cannot cope with the inveterate prejudices of a rural population, or overcome the inertia of reluctant authorities.

Every village green and every babbling brook requires the protection of a vigilant conservancy to preserve it from contamination by instant remedies; and in the long-promised Government measures we would suggest that everywhere the simple word '*shall*' should be substituted for the lame and impotent '*may*' of the existing statutes, and that the well-considered recommendations of the Rivers Pollution Commissioners should be invested with the sanction of law, without further procrastination.

We subjoin a few examples of salient provisions, by way of illustration, and for the consideration of local authorities before framing their bye-laws:—

1. That no person shall knowingly permit any noxious gas or exhalation injurious to life to issue from any chimney or other part of any dwelling, factory, works, mill, or other premises, at any time after due notice prohibiting the same shall have been given to the owner or occupier by the local authority.

2. That no refuse matter, sewage, waste, or other noxious or polluting thing shall be knowingly permitted by any owner or occupier to pass from any dwelling-house, stable, or other building, or any farm, fold-yard, factory, distillery, slaughter-house, or other premises, through any open drain or covered channel, into any stream, ditch, or natural water-course, or any canal, dock, basin, reservoir, or stagnant pool, unless such refuse, sewage-water, waste, or other matters shall have been previously cleansed from all noxious and polluting ingredients within

the limits of the standard of pollution of effluent waters duly prescribed for the district.

3. That in villages and places *where no special system of drainage exists* the rural sanitary authority for the time being shall provide, in proper and convenient situations, ashpits, boxes, or other receptacles for the temporary deposit of dust, ashes, fæcal matters, refuse, rubbish, or dung; and shall also at stated and convenient times collect and deposit the same in fit buildings, pits, or other places, and shall there cause the contents to be deodorised by layers of common soil or otherwise; and the same shall be sold or disposed of by the sanitary authority, and the proceeds thereof applied for the common use and benefit of the district: provided always that where any such matters are retained and preserved by any owner or occupier upon his own premises, or for his own use, as manure or otherwise, the same shall be kept so as not to be a nuisance or injurious to the public health, and shall be subject to the inspection of the officers of the Board, and to all bye-laws in that behalf made and provided.

4. That no cesspool, or other receptacle for the collection underground of any drainage, filth, or other noxious matter, shall be constructed or used upon any ground, garden, or premises, unless the same shall have been rendered water-tight by means of cement or asphalte, or be distant at least fifty yards from any public or private well, spring, pump, or fountain which is used for drinking purposes by

any of the inhabitants of any town or place; and that no new well, pump, or fountain shall be sunk or constructed within the same distance from any already existing cesspool, whether upon the premises of the owner of such cesspool or otherwise.

5. That no water-closets shall be used or constructed in any dwelling, unless the owner or occupier shall have previously satisfied the rural sanitary authority for the time being that proper provision has been made for receiving and discharging the contents of the same, so as not to be a nuisance or dangerous to health by reason of pollution of any wells or watercourses, or otherwise.

6. That upon complaint made by any aggrieved person to the said rural sanitary authority of any nuisance, or other infraction of the above provisions, the said authority shall enquire into the same, and give notice in writing to the owner or occupier of the premises where the said nuisance shall be found to exist, to abate and discontinue the same within one calendar month from the date of such notice; and in default of such abatement and discontinuance shall enter, by their proper servants and officers, upon the said premises, and there do all things necessary to be done and performed in order to prevent and remove any such nuisance or cause of complaint as aforesaid, but at the sole cost and charges of the said owner or occupier, to be levied by immediate distress or otherwise upon the said premises.

The foregoing clauses comprise those cardinal

provisions of sanitary organisation which 'will insure the highest condition of health, and prevent disease.' They are axioms of the new philosophy, and when they are enforced throughout the rural districts we shall have done much to arrest the plague of river pollution and endemic fever.

To many readers they will appear far too drastic and stringent, perchance altogether incompatible with modern ideas of luxurious civilisation; and we can picture to ourselves a shower of remonstrances on every side from those who cherish the Englishman's assumed right to do as he likes, for good or evil.

'Your precautions,' they will protest, 'will render our existence intolerable.' 'Society is governed not by Procrustean theories, but by a carefully adjusted balance of mutual conveniences.' Howbeit, mankind can never ignore the silent and unerring processes of nature! To the purblind groper on this earth's surface these pestilences and pollutions might seem to be evil; and viewed by man, peradventure from the bottom of a well, they assume the fancied shape of national disasters; but the serener eye of philosophy discerns in them a deeper lesson, and reads 'books in the running brooks, sermons in stones, and good in everything.' Truly, there are 'diversities of operations; but it is the same God which worketh all in all.'

Fifty years have passed since the invention of the water-closet, and men only now are beginning to discern the violation of a law in this wholesale and

reckless pollution of water. They are blind to the phenomena beneath their feet, and altogether deaf to the voice of nature, exclaiming with inexorable logic, '*Nemo me impune lacessit!*'

'Go! wash, and thou shalt be clean!' But where, in this year of Christian grace, shall we find a Jordan for our leprosy? Is it not, we ask, high time to abandon a paltering and lukewarm hesitation? And he would be a false guide who, disloyal to his own convictions and without the courage of his opinions, prophesied in this emergency smooth things to the people.

The spirit of Demetrius and his fellow-craftsmen of Ephesus is still rampant in the world—that spirit of selfishness and incredulity which refuses to be persuaded without a sign from Heaven. Let us not wait supinely for another portent—the cholera or the cattle plague—but take up arms against our troubles, 'and by opposing end them.' *Sic utere tuo, ut alienum non lædas*, should be the motto of our legislation; for it can no longer be tolerated that the 'sewage filth of one town should flow through and be the water source of another.'[1]

They who would fain remove these off-scourings from their own lines and pleasant places, and inflict the burden on their neighbours, have yet to learn that it is a shallow and a selfish policy, which like to the curses of the Arab proverb will, sooner or later, come back to roost.

[1] Parliamentary Report of Commissioners on the Sewage of Towns.

Rather let them take heed from the fate of Richmond and her sisters on the Thames, whose once 'shining shingle' is smeared with unsightly ooze; and strike resolutely at the root of that baleful system which has corrupted the sources of our national wealth and prosperity.

CHAPTER VIII.

ON THE RELATIONS BETWEEN RURAL SANITARY AUTHORITIES AND THE CENTRAL GOVERNMENT, AND ON THE MODE OF PROCEDURE WHERE ACTION IS NOT TAKEN BY LOCAL AUTHORITIES.

THE passing of sanitary laws, and the creation throughout the country of local authorities empowered to enforce them, are not alone sufficient to insure an improved sanitary condition. It is necessary that there should be also a Central authority or department overlooking the local bodies, and able to exercise a certain amount of control over their proceedings. As with all other administrative action, ultimate control must rest with the representatives of the people who make the laws. Local authorities are not answerable to the people at large, but only to their own constituents. The Central Department, on the other hand, is directly responsible to Parliament. It is therefore only through it that the actions of local authorities can be brought into accordance, as it is right that they should be, with the general desire and wish of the nation.

The sanitary condition of localities is not of importance to those localities only. It is of importance to the people at large. The consequences of unhealthy conditions in a village or community are

never confined to that community. If infectious disease is generated, the inhabitants go elsewhere and spread it. If there be, without special disease, a general low state of health, as the result of dirt and bad living, this also is communicated; and if not immediately, at least in the next generation, its effects must be felt far and wide, to the detriment of all around. Again, the habits of neglect in which the young especially are brought up, and which they make their ordinary style of living, knowing no other, are carried by them wherever they go; and carried too to localities where, by reason of closer population, or from other causes, they are likely to produce more serious results. No community can be entirely isolated. No community can defy sanitary laws without injury, not only to itself, but to the nation of which it forms a part. And that nation has a right to say to each community, 'Even if it be your deliberate wish, or that of the majority of you, to risk disease and degeneracy rather than incur certain trouble and expense as other communities have done, even if this be your wish, you shall not do it. You shall observe our wishes rather than your own, and you shall not do that which is an injury to us as well as to yourselves.'

And in order that effect may be given to the nation's wishes in these matters, it is necessary that there should be a Central, as well as local authorities, to administer the sanitary laws. The first duty of the Central authority is to stand between the Legislature and the local bodies. It has to some extent

to interpret the laws; it has also to supplement them by specific regulations, in matters left to its discretion by Parliament; then, if need be, it has also to enforce the carrying out of those laws and regulations by the several authorities. And, where it takes no action of itself, it has still, for the information of Parliament, to record and take account of the proceedings of the local bodies.

The first reason for the existence of a Central authority is that it would be practically impossible otherwise for the nation at large to have any control over local governments.

There is, however, another ground of necessity in the fact of the necessary possession by it of superior technical knowledge and experience in sanitary questions. Hence it becomes an important function of this authority to give advice where it does not take action. It has, or at least should have, the best scientific knowledge of the day at its command, and it has also of necessity the latest and most general experience and knowledge of results. Local authorities are less advantageously situated in this respect. It is on this account desirable that there should be a Central body accessible to give advice, if sought for; and it is desirable also for this purpose that all plans and proposals for work on a large scale should be submitted to it for consideration and report, although not necessarily for decision.

The need for control, however, as well as advice, by this department is obvious for reasons already

stated, but it is desirable also on many grounds to narrow as much as possible the limits within which such control can be exercised. It is the opinion of the writer that the independence of local authorities should be preserved to the utmost extent compatible with observance of the general laws. Interference should be avoided wherever it is possible, consistently with this. Local boards have to answer to the country for the observance in their districts of the country's laws, but as to all other matters, and especially as to ways and means, they have to answer to their own constituents. They, and not the Central Department, have to bear the responsibility in case of failure in any work undertaken. The advice of a department or its officer is generally gladly received, but if, after receiving that advice, and after time for consideration has been given, an authority be found to persist in an application; if it be not an altogether unreasonable one, if it be a way of effecting the object in view, although not the best way, they should not, it is thought, be prevented from carrying it out. It is better that a local body should sometimes spend money or take other measures unadvisedly, than that responsibility should be taken from those who ought to bear it. And adverse decisions by the department on plans or proposals approved in a locality, if the ground for such decisions be not appreciated, are likely to lead not to better plans, but to entire inaction for a lengthened period.

Now, under existing legislation and practice, the

control of the central authority—viz., the Local Government Board, is exercised principally in the following ways. First, it has control over all alterations of existing districts, and arrangements for combination between districts; second, it has control over all works for the carrying out of which money has to be borrowed, as this cannot be done without its consent; third, bye-laws cannot be enforced without its sanction; fourth, with regard to appointment of medical officers and inspectors, it has power over such appointments whenever the payment of part of the salary is accepted from the public money. In these respects, and some others of minor importance, the Board does not initiate or take action of itself, but has the power of control or veto over proceedings proposed or commenced by local authorities. Then, again, the Board make some regulations from time to time applicable to all authorities throughout the country—viz., as to an annual report required from them, as to audit of their accounts, as to the duties to be performed by all medical officers; and, in case of epidemic disease, as to special precautions and treatment. These, with the exception of the last, which only takes effect on emergency, are powers for obtaining information and record rather than for the accomplishment of sanitary work. Then there are further powers of direct interference in specific cases. The Board may enforce on local authorities the following duties, which are otherwise optional—viz., the scavenging and removal of refuse throughout their

districts, the cleansing and watering of streets, regulation of lodging-houses, and provision of mortuaries for reception of the dead. In case of a nuisance, if the local authority have failed to interfere to prevent it in the manner they are empowered to do, the Board may authorise an officer of police to do this instead of them. And in case of default to construct sewers, to provide a supply of water where it is required and can be obtained at a reasonable cost, or to enforce any provisions of the Public Health Act, the Board may either make an order upon the local authority to do these things and move the Courts to enforce it, or may appoint a person to carry out the works required.

The principal part of the work done by the Board consists probably in granting facilities to local authorities for carrying out work. And perhaps one of the most important services it renders is that of applying to the Legislature on their behalf for special powers not otherwise obtainable, especially in respect of consolidation or alteration of districts, and taking land by compulsion for sanitary works. The Board, on being applied to for these purposes, if satisfied of the reasonableness of the objects sought, issues provisional orders granting the powers desired, and then introduces in the next session of Parliament a Bill to confirm them. A provisional order is of no effect unless confirmed; the Board therefore does not of itself confer any power, but only facilitates, and very greatly so, the process of obtaining

it. Practically, if a local authority requires for the purpose of sewerage or water-supply to take land either within or without its own district, all it has to do generally, after giving proper notices, is to prove the reasonableness of its object to an inspector of the Local Government Board. A provisional order will probably be granted in accordance with his report, and in due course will be confirmed by Parliament and become law, without further action on the part of the authority. Opponents will have had an opportunity of objecting before the inspector at a local enquiry, and they can if they please continue their opposition before a Committee of either House of Parliament. But considering the small extent of the requirements in these respects, at least of rural authorities, and the extent of ground within their reach and choice, it is not often that in order to comply with the needs of their districts they will have to provoke opposition to this extent. The effect therefore, as far as they are concerned, is almost the same as though the Board itself gave the power. It is generally obtainable through them without trouble, and it is not obtainable without them, except by the long and expensive process of promoting a private Bill, which, even if introduced, is hardly likely to be passed if disapproved by the Board, as Parliament now always requires before dealing with such Bills a report thereon from that department.

As to modification of areas and jurisdictions, the Board have certain powers of themselves which may

be exercised without application to Parliament. They can authorise districts to combine for the purpose of appointing medical officers and inspectors (indeed, this is one of the proceedings which they can sometimes compel), but not for other purposes. They can give power to build sewers communicating with those of other districts, and to supply water outside districts. They can authorise the subdivision of existing areas to the extent of constituting any places therein special districts for purposes of drainage or water-supply, and they can confer upon rural authorities any of the powers of urban ones with reference to the whole or any portion of their jurisdiction. With regard to proposed combinations or alterations other than these, the Board, as with proposals for taking land, can only proceed by provisional order, requiring the subsequent confirmation of Parliament. But, directly or indirectly, the Board is required to sanction, and thus obtains a veto on all proposals for alteration of areas, as constituted by the Act of 1872, or for combined actions by them in respect of sanitary works, as well as over all works for which land has to be taken without consent of the owners.

Again, the fact that the sanction of the Board is required for power to borrow money, gives them practically a veto over the construction of works of all kinds, except such as are of very small extent, and can therefore be paid for out of current rates. And the similar sanction requisite for enforcing bye-

laws has the same effect as to any systematic method of dealing with removal of refuse.

Local authorities can thus take very little practical action in any branch of sanitary work, whether sewerage, sewage disposal, water-supply, or removal of refuse, without referring to and obtaining the consent of the Local Government Board. Although the Board generally initiate nothing, even to the extent of advising it, they have nevertheless a veto over nearly everything that can be done. The effect of this is likely to be beneficial or injurious principally according to the use made of this power.

It would not be well that the boundaries of districts, as constituted by law, should be altered without sufficient cause, or that the authorities should be permitted too readily to further subdivide their jurisdictions. The constitution, for instance, of certain small special drainage districts, under the legislation prior to 1872, proved sometimes, instead of a help, an effectual bar to improvement. On the other hand, rural districts, as coincident with Poor-Law Unions, are often very inapplicable to form sanitary areas, both from physical conformation of ground as to drainage, and from varying condition and interests of population in different parts; and it is very desirable sometimes that there should be the means of effecting modifications, in order that sanitary works may be carried out with more advantage. The action of the Board should be exercised to insure that the interests of all parties are duly heard and considered, rather than to stand in the way of

any separation or combination generally desired in a locality.

Again, as to borrowing powers: The amount of local indebtedness is no doubt of national concern, for failure to repay or meet the interest on loans by any local body would affect the credit of all others. This, however, is provided against by the general law, which requires that the amount of loans outstanding in any district shall in no case exceed two years' rateable value, and that loans should not be granted except for works of a permanent nature. It is desirable that there should be a Central Department to take cognisance of all loans in order to insure the keeping of this law. Nor even within this limit would it be well perhaps that local bodies should be left altogether to their own ideas in the matter: for where the total sum available is limited, expenditure on a matter of minor importance may of course operate to render impossible at a future period something of much greater consequence. It is much to be regretted when public bodies by unnecessary outlay of any kind place themselves in a difficult position for doing the work really necessary to preserve the health of their districts. Still these are matters the responsibility of which must really rest with the local governments themselves, and the function of the Central authority should be advice rather than interference so long as the legal limits are not proposed to be infringed.

The Local Government Board, it should be observed, if they approve a proposed loan, have

the further power of facilitating it by recommending the Public Works Loan Commissioners to advance the money at the rate of interest at which it is their practice to lend. This rate is lower than can be secured elsewhere—viz., at the present time, $3\frac{1}{2}$ per cent. for loans repayable in thirty years, and 4 per cent. for those extending over longer periods.

The granting of this recommendation, and the application for special powers from Parliament through the system of provisional orders, are matters within the discretion of the Local Government Board; and their assistance in these respects could not by right be expected towards objects which they do not entirely approve. As to the other proceedings for which the sanction of the Board is requisite—viz., formation of special districts, powers outside districts for sewers and water-supply, approval of purchase of rights, borrowing powers, and bye-laws, it appears to the writer that sanction should seldom, if ever, be withheld, so long as the general laws are observed. The reference to the Board in all these cases is desirable in order that the legality of the proposed proceeding may be proved, that full time for consideration may be taken, and that the advantage may be obtained of the opinion and recommendations of the skilled advisers of the Board; but, in order that the responsibility of local authorities may be duly preserved, the power of giving a final veto, even to proceedings not altogether approved, is one that should be used most sparingly.

It is otherwise where no action is taken at all

by authorities in respect of matters distinctly committed to their charge by the laws under which they are constituted. In this case active intervention by the Central authority is essential; and but for this, laws which are made for the whole country, and the benefit of which depends on their general observance, would be liable to remain here and there a dead letter. The law requires of rural authorities that they 'shall' do certain things; that they '*shall* provide that all drains, water-closets, privies, ashpits, and cesspools, within their district, are kept so as not to be a nuisance or injurious to health;' that they '*shall* keep in repair all sewers belonging to them;' and that they '*shall* cause to be made such sewers as may be necessary for effectually draining their district.' It is as much the duty of boards of guardians as sanitary authorities to do these things, as it is for them to maintain any pauper that may have a settlement in their parishes. Of course the performance of the duty is often by no means so simple and straightforward a matter as in the latter case; it may be a very difficult and complicated one; still, if there be anything existing which is injurious to health, it is the duty of the authority to remedy it; and if any person can point out a means of doing so, then there is at once a plain duty to adopt such means, unless better can be discovered.

And if necessary action be not taken by authorities, the Local Government Board has the

power of compelling it by two or three different methods.

In case of nuisance on a small scale, such as that which may be caused by an individual, if the local authority does not proceed against the offending party to cause him to remove it, the Board may authorise any officer of police of the county to take the steps which they could have taken in their place. These are to give notice to the occupier or owner of the property whence the nuisance arises, to abate it; then, in case of default, to enter and do the necessary work at his expense. This applies to nuisances on a small scale, such as those which may arise on individual properties. Then to come to larger matters, and those for which more extensive remedies are required, if there be default in 'providing sufficient sewers,' in 'maintenance of existing sewers,' in 'providing a supply of water where danger arises to health from the insufficiency or unwholesomeness of the existing supply, and a better one can be obtained at a reasonable cost,' or in 'enforcing any of the provisions' of the Public Health Act, which it is their duty to enforce, the Board can proceed now in either of two ways. The first is to make an order on the local authority to do the work required, and obtain a writ of mandamus from the Superior Courts to enforce compliance with it; the second, to appoint some person to perform the duty instead of the authority adjudged to be in default. Both of these proceedings have been had recourse to from time to time. The

procedure by mandamus is recent, having been allowed for the first time under the Act of 1875; whereas the power of appointing persons to perform duties in the place of local authorities has been in force since 1866; and several works, both of sewerage and water-supply, have been carried out under it. There were several difficulties, especially at first, in the way of this proceeding, but most of these were removed by subsequent legislation, and many of the works so initiated have been carried to a satisfactory conclusion, and proved of advantage to the localities. Probably, however, the expense has been in each case somewhat greater than if the same work had been done in the usual manner.

These modes of proceeding must always be exceptional. No kind of action could be enforced in this way that was not a proved necessity in the opinion of the great majority of the people. There must be a clear case of need for work to be done and of refusal to do it on the part of the local authority before the Central Department can interfere in this way, and take the matter into their own hands. Still it should be known throughout the country, in every district and parish, that there is this power, and that it is employed on occasion; and that, in consequence, no person need continue to live in danger of disease or even discomfort from removable causes.

It matters not whether injurious effects be due to individual acts of neighbours, or to a general pollution of soil or atmosphere which works on a large scale are required to remedy; if the causes,

whatever they are, be removable, any person affected can claim their removal; and in default of the local authority can apply to the Local Government Board. It is immaterial from whom the complaint to the Board may arise. On a proper representation of the circumstances, if the matter be of sufficient importance, they are bound to make enquiry, and will proceed, if the necessity for work be proved, to make an order on the local authority to do it.

The value, however, of compulsory power in the hands of a Central Government is likely to be greater in its indirect effect of impressing on the country generally the importance of sanitary work, than in any direct results which will be obtained by its exercise in the few instances in which it is brought into action. Improvement will be brought about principally by the spread of knowledge and information generally, and by increased sense of responsibility on the part of local authorities; by their being made to feel that the eyes of the country are upon them, both to notice neglect and to support the enforcement of all useful measures. Rural boards of guardians had, by the legislation of 1872, an entirely new class of duties thrown upon them; and it was necessary, before they could be expected to take action on any large scale, that some time should elapse wherein they might inform themselves respecting the nature of those duties. A reasonable period for this, however, has passed by; the authorities are now invested with all necessary legal powers, and are, or should be by this time, fully informed of the neces-

sities of their districts, through officers of their own appointment; there is now, therefore, no reason why unhealthy conditions should continue to exist, or at least why their removal should be delayed by other than insurmountable physical causes.

NOTES BY THE EDITOR.

Necessity for stringent Legislation to prevent Pollution of Rivers and to secure a Supply of Pure Air—Dangers resulting from Cesspools — Advantages of Sanitary Officers keeping Maps and Registers of Public and Private Sewers—The Pioneers of Sanitary Science—Pure Air essential to the Preservation and Restoration of Health—Power of the Human System to resist Disease—Means available for the Disposal of Sewage—Scavenging.

The new dogmas necessary to be propounded in order to render sanitary legislation complete in this country, so as to secure the realisation of the title of the present work, need be but few in number; but they would require to be stringent in character. They would more or less affect the territorial, manufacturing, and mining interests, but only so far, however, as these interests are responsible for the existence of the present state of things. The Rivers Pollution Commissioners, whilst describing the evils arising from the discharge into rivers of sewage from towns and villages, and the filthy refuse from manufacturing works generally, report that 'in every case efficient remedies exist, and are available without risk to the public health or serious injury to the processes or manufactures.'

Of all the forms of river pollution arising from metal works, that caused by galvanising works is by

far the most serious. Birmingham and Sheffield are the principal centres of the galvanising trades; and the injury occasioned by the action of the waste liquors from those industries is so serious that the Corporation of Birmingham have applied to Parliament for powers to prohibit their discharge into the sewers; and the riparian proprietors of the Don, which flows through Sheffield, have framed a special Bill for a similar purpose; but South Wales is the principal seat of the tin-plate trades, and the rivers of Glamorganshire especially give proof of the serious nature of the poisonous fluids poured into them from tin-plate works. The report under notice[1] gives a tabular statement of the results of analysis of seventeen samples of waste water from galvanising and wire works, the figures in which clearly 'prove, in the most unmistakable manner, the highly polluting and strongly acid character of most of these discharges;' and, adds the report, 'their noxious properties are in many cases greatly intensified by the reckless manner in which they are suddenly discharged in large volume into sewers and streams, dissolving the cement, and thus loosening the brickwork of the former, and destroying the fish in, and otherwise rendering useless, the latter. There is no necessity whatever for thus getting rid of these waste liquors; and the interdiction of their escape from the factories would be no hardship to the manufacturer, but would, in most cases, yield him a considerable profit.'

[1] *Fifth Report of the Rivers Pollution Commission*, p. 35.

'In previous blue-books descriptions have been given of the [1] "evils arising from the discharge into river channels of town sewage, and of the various filthy drainage waters from cotton, woollen, silk, flax, and jute works, from print and dye works, from tanneries, paper mills, and bleach works, from alkali, chemical, and soap works, from distilleries, starch, and sugar works, and from paraffin oil works."

[2] 'So far back as 1859 Dr. Lyon Playfair found arsenic in the water of the river Kinder and the reservoirs of a waterworks supplied therefrom. This river—a tributary of the Mersey—has its source in the hills of Derbyshire, and the water is used by calico-printing establishments situate on its banks. He also found arsenic in the mud taken from the outlet of one of the works. He used "Marsh's apparatus" in the analysis.

'In one pound of residue left after drying the mud taken from the outlet 4·10 grains of arsenic were obtained by another professor of chemistry, and 9·84 grains per gallon of solid matters in solution, and 10·4 grains of suspended matter were obtained.

'One pound of residue left, after drying the mud from the water works reservoir at 212°, gave—arsenic, 1·58 grain; lead, 7·68 grains; copper, 3·69 grains.

'A third professor of chemistry found from actual experiments on the colouring matter obtained from madder, and held in solution, even in water at rest,

[1] *Fifth Report*, p. 1.

[2] *First Report*, vol. ii. *Minutes of Evidence*, part 3, Q. 1031.

the colouring matter was not thrown down for two or three days.

'From one pound weight of mud from a settling reservoir 4·17 grains of arsenic were obtained. It is a cumulative poison; yet if this quantity were taken in one dose it would more than suffice to poison a man.

'To afford some idea of the quantity of dye-stuffs and chemicals consumed at calico-printing works, the establishment above referred to used in three months 215 tons of solids and 8,894 gallons of liquids.

'There are no counties in England where the streams are worse polluted than those of Lancashire and Yorkshire. The river Irwell, which passes through the city of Manchester, is a reeking sewer, of which the rivers Irk and Medlock, and a foul stream called the "Cornbrook" are tributaries. The waters of these rivers are as black as ink; and, in addition to their many impurities, the sewage of Rochdale, Oldham, and other populous places, is brought by them through the city. The corporation turn many million gallons of water into the Irwell; its water is, therefore, less polluted on leaving the city than when it enters. In Broughton and other low-lying districts diarrhœa prevails more or less, and this river's foulness is becoming a serious and urgent matter to the inhabitants of the city.'

There are old residents still living who have fished in the Irwell, but owing to the increase of towns and manufactures its waters have gradually and still continue to get worse. The Lancashire

dyers and others constituting the deputation from Manchester that recently waited upon Lord Salisbury, are no doubt terribly alarmed at the idea that standards of pollution of effluent waters will be established. Calico-printing and dye works send into the streams some of the most villainous compounds—as above shown—that it is possible to conceive.

'Mr. Legh, M.P., has stated that there were hundreds of acres of agricultural land near the Mersey that were perfectly useless from the effects of vapours from copper-smelting works which had not come under the Alkali Act of 1874.'

Successful legislation upon this important subject requires a strong, courageous, and enlightened Government, one that would be content, like the repealers of the Corn Laws, to brave all consequences, and to wait for a future reward in the blessing of a healthy and a grateful people.

We have at present a Government which has given utterance to strong expressions upon this subject, and which the country has a right to expect it will take steps practically to carry out. When the Prime Minister announced that 'the first care of a minister was the health of the people,' followed by '*Sanitas sanitatis omnia sanitas*,' and 'Sewage is King,' a new era appeared about to dawn upon us, and encouraged the hope that long ere this we should have seen the realisation of that enlightened sanitary policy which the enunciation of the important axioms above referred to clearly

indicated. Instead, however, of having obtained a really good Rivers Pollution Bill as an instalment of legislation on this important subject, we fear there are 'looming in the distance' evidences that the Government which spoke so encouragingly on coming into power will allow the golden opportunity to slip by them. To complete the great work of sanitary legislation, and to place England in the foremost rank of health-seeking nations, would require the enactment of the following edicts:—

1. The rivers and springs *shall* not be polluted.

2. The people *shall* have secured to them pure air in and around their dwellings.

The means to be adopted for carrying out these two precious canons may be left with the greatest confidence to the Government that will fearlessly undertake their enactment. Nothing short of this will accomplish the object in view. All legislation has been in the same direction; and we have now learned that, speaking broadly, the seeds of all preventable diseases are taken into the system either through the water we drink or the air we breathe. We have in nature both these substances provided for us in a condition fit for our consumption; and it does not appear to be demanding too much to have them restored and preserved to us in the condition of purity in which our Maker gave them.

It may perhaps appear unnecessary to enlarge upon the statements, and overwhelming evidence in support of such statements, to be met with in the previous pages of this work in confirmation of the

assertion that the seeds of almost all preventable diseases find their way into and poison our bodies, either through the water we drink or the air we breathe. Medical opinion will fully bear out the truth of the assertion. We feel we cannot do better than include here a few remarks on this subject taken from the paper of Dr. Ward, of Grange-over-Sands.

'It is to be deplored that in proportion to the extended means of procuring the comforts and accessories of modern civilisation, in many instances, especially in the country, there has been a corresponding departure from the first principles of health.

'The water-closet system, with its usual country accompaniment, the cesspool, has not infrequently made the isolated mansion and the rural villa a very hotbed of disease: the devitalising effect of a house atmosphere contaminated with decomposing excrementitious emanations has brought in its train a strong predisposition to typhoid fever, and a long catalogue of diseases pointing to blood-poison, either generated within the system, or received from without; whilst the depressing effect of such evils on the digestive and assimilating processes will account physically for many instances of resort to excessive alcoholic stimulation as an artificial means of retarding the waste or renewing the wear of the system.

'As a means to reduce the long roll of mortality and suffering which arises from this defilement of the atmosphere within and around our dwellings, I would reiterate and urge the plea of Dr. Guy, that

the existence of closed cesspools shall be made a misdemeanour. Cognisant of the amount of ignorance which prevails with reference to the evil induced by these receptacles, and of the deep-rooted prejudice which exists in their favour, it would seem as if nothing short of legislative prohibition can stop the widespread calamity which their presence entails. The ventilation of channels of communication with these receptacles, though an improvement on the recent past, is not sufficient to obviate their danger; and it is not too much to denominate cesspools the curse of domestic sanitary civilisation. If allowed at all, and this only where ample space and other convenience permits, they should be removed many yards from the house, away from wells and watercourses, be freely exposed to the disinfecting properties of dry soil or fresh lime and atmospheric air, provision for the removal of the liquid part having been duly effected; their contents should be frequently emptied and buried, or rendered otherwise innocuous; roofing boards, or other light covering, only should be permitted to keep out the rain; and the regulations to be observed in relation to sewers leading thereto should be similar to those which should be required for town closets, with some modifications.

'Surprise has often been expressed that villages surrounded more or less with accumulations of slops or other filth should frequently possess such an immunity from disease, forgetting that these offensive collections (which should, nevertheless, not be

tolerated) are robbed of their virulence from free exposure to the atmospheric air, aided by water and porous substances.

'The important truth that unventilated drains, cesspools, and other closed-up collections of decomposing organic matter, are especially dangerous, cannot be too strongly impressed upon the public mind.

'I would urge that every sanitary authority be compelled to keep a map of the system of sewers existing in its district; and also that local authorities should require a plan to be sent to them when any alteration is contemplated in the disposition of the drains of any premises within their district. This provision would'—as it has been already suggested—'be invaluable in case of the outbreak of epidemic disease, and might save much trouble in time to come. I would also urge that every sanitary authority be required to be furnished with an inventory of all closed cesspools existing within its district; and that a limited time of grace should be allotted to their existence when not fulfilling the requirements of modern sanitary science—comprising, position remote from the dwelling, fullest ventilation, frequent free admixture of disinfectants or deodorizers, such as dry garden or clay soil, peat, charcoal, quicklime in a state of pulverisation, careful drainage, and frequent cleansing. I am satisfied this enactment would in many instances be productive of inestimable benefit, especially if at the same time the situation of sewers underneath inhabited dwell-

ings—which should not now be permitted—were also required to be furnished to the same local board. We should thus be furnished with a key, which in many cases would unlock the mystery of disease. Many an imposing country mansion or less pretentious residence—which, as a trap to betray the unsuspecting, has caused the pangs of bereavement to be felt again and again—would have to undergo thorough overhauling in its basement, or to remain—as it should—untenanted. The rats, too, would be astounded at such an unsuspected inroad upon their long-secured and accustomed privilege, and, in their useless protest, make the long-wished-for *exeunt.*

'The new powers granted by the Public Health Act of 1875, enabling the Local Government Board to assign to medical officers of unions in any constituent district duties which they are to perform in rendering local assistance to the medical officers of health, might, I suggest, be beneficially directed to the furnishing of that functionary with information of all cases of contagious zymotic disease which have occurred in houses in their districts within a given time—say, so many years, from the fact that any given house may not have been occupied by children or individuals ordinarily susceptible to such diseases for some time—that special attention shall be directed to ascertain the sanitary arrangements of such houses, with a view to their improvement A work that may well engage the attention of the medical officer and engineer, or other skilled or practical official of the local authority, and will, it is.

firmly believed, be productive of incalculable benefit to succeeding tenants and the public at large, whilst, if needful, the statistical report which the medical officer may have to return periodically, may perhaps be withheld without detriment to the health of the community.

'The provisions of the Acts 18 & 19 Vict. cxxi., 8 & 12 and 29 & 30 Vict. xc. 19, may thus be beneficially called into operation, and prove the necessity for extending the powers of the Local Government to buildings already existing, and not confining its power to those to be erected only, unless the bye-laws which may be made with respect to the structure of buildings "for purposes of health," include this in their provisions. There are instances where drains from farmyards, farm buildings, &c., are constructed or allowed to pass underneath dwelling-houses, or where the soil of the foundation or enclosed area of the habitation is more or less saturated or contaminated with liquid manure, from proximity to the homestead and faulty situation; yet again is it sometimes seen that cattle are housed in winter under the same roof as the farmer's or cottager's family, separated, it may be, only by an insecure and highly porous partition wall, and if it should happen that the portion of the building devoted to the accommodation of the cattle is on higher ground, so that the foundation and area of the habitation become impregnated with animal filth; and if, at the same time, the open-throated, sky-inspecting chimneys of the past, with their free ventila-

tion, should be superseded by modern ones, warranted to obtain or retain warmth at any cost, even at the cost of health, disastrous indeed are the consequences. The young occupants experience the full and aggravated force of any epidemic influence which may invade the district; typhoid fever here finds its native home, and if this foul confined air has left one of the family offspring remaining, it is, perchance, but to fall a prey to pneumonia, pulmonary consumption, or chronic kidney disease; whilst the old drag out a miserable existence, subject to chronic maladies, to be mercifully terminated by some subacute visceral inflammation, it may be; or, on the other hand, to be protracted further for awhile, till some hideous form of cancer completes its havoc on the hapless inmate. The next tenant of the farm, once so greedily sought after, and which, it is well known, enabled its remote predecessors to obtain a comfortable competency by ordinary application for their declining years, goes but to tell the same sad tale of domestic suffering and bereavement.

'How long shall this stealthy, deadly foe be encouraged to invade the houses of all classes of the community? The laws of health cannot be outraged with impunity. But who is to take the initiative, to remove the reproach? Is it the only way to educate and arouse public opinion so as to tolerate it no longer? Or are we to expect our medical officers of health, elected and retained in office by the suffrages of the people in whose midst they move, and who too often find favour in proportion to their non-

interference, and are tolerated as an infliction of the powers that be, who sit enthroned somewhere near Westminster or Whitehall;—are we to expect them to take the bull by the horns, and bid defiance to the supposed vested interests of their near neighbours, through whose approbation alone they now will hold office? Or can some amicable negotiations be entered into, ostensibly by the central authority, with the owners, to induce them to avail themselves of the provisions of the several Land Improvement Acts; and by its aid, convert these pest-houses to the sole use of the cattle, for which they would be more suitable if amply ventilated; and erect some useful dwelling for the farmer on a high healthy site, some distance removed from the cattle homestead, and constructed in accordance with enlightened principles of health laws? It is a consummation devoutly to be wished!

'The inspector of nuisances is supposed to have his eye upon accumulations of manure and other decomposing refuse near dwellings, and to enforce, where needful, their speedy removal to the site of their ultimate destination on the farm, as far removed from the roadside, or where they may be as little offensive as possible; whilst each local board will, it is hoped, appoint or depute some suitable party to apportion the work of its staff of scavengers —one or more—without whose services it would seem impossible to rely on the performance of the duties so essential to the well-being of the ratepayers—such as frequent removal of contents of earth-closets

and privies, street cleansing, and attention to the disposal of the slop water. It would not unlikely be partially self-remunerative or productive from the sale of waste products.'

If we may appear to have dwelt too little upon medical testimony in support of the necessity for sanitary legislation it is because the voice of the profession has been heard speaking with no feeble note from the very first dawn of sanitary science. The world has to thank the profession for the honourable, able, and unselfish manner in which they have advocated the adoption of sanitary measures for the prevention of disease, long before such subjects found any favour even with the most enlightened of the public. Doctors are not, however, law-makers, any more than they are engineers. The question has advanced many stages since the sanitary doctors first lent their valuable aid and experience in demonstrating that so much sickness and death was preventable. Since the fact of the possibility of lessening the amount of human suffering by the institution of proper sanitary measures has been brought home to us, we now look for the enactment of such laws as may free us from the evil consequences for the future. The engineers are ready to devise means to carry out the necessary works to accomplish all that is required, if only the powers are forthcoming to enable them to do so.

Sanitary legislation necessarily and wisely moves slowly, but it must not be overlooked that whilst vested interests are being so carefully considered

valuable lives are being constantly sacrificed. The failures which attended many of the early efforts for the disposal of sewage refuse no doubt tended to rouse the opposition of the ratepayers, out of whose pockets the expenses of sanitary boards have to be defrayed. There could be no injustice, however, after so much careful consideration has been given to the subject, in passing a stringent *prospective* measure to prevent further pollution of rivers, allowing a *moderate* interval to elapse for the removal of existing sources of pollution. General Scott was right when he said at Belfast 'Go on, do something to improve your effluent waters—time and the progress of knowledge will do the rest.' Pure air and water can scarcely be too highly valued, but the difficulty of enjoying the one or the other is heightened by the growth of our towns and the increase in our manufactures.

The Rivers Pollution Commissioners urge upon the Government the necessity for legislation with a view to the prevention, so far as may be practicable, of the continued pollution of rivers and streams; to prevent solid matter being thrown, or allowed to go, into a river; to prevent sewage going into a river; and to prevent the river being polluted by the various works on its banks;—the standards of purity to be such as could be complied with by all parties interested, and Government inspectors to be appointed for certain districts. Mr. Henry Tyson, of Hulme, suggests that an analytical chemist properly constituted (by examination) for a certain district

would be the fittest person to decide any question upon the standards of pollution, and not a County Court judge, or any other law officer. The same gentleman remarks in his paper on Rural Sanitary Science: 'The necessity of pure air for the maintenance of health is so little understood that in consequence the ventilation of houses is utterly neglected.

'There are numerous persons pursuing their various callings in different parts of the country who have neither the time nor the inclination to learn, or inquire into, the effects of the application of air and climate as means of preserving health and curing disease; or the generation of malaria and noxious gases—the evils resulting from "overcrowding" in cottages; and from breathing damp and stagnant air.

'Fortunately the odour of sulphuretted hydrogen can be readily detected in the atmosphere by its garlic-like smell. A combination of even a thousandth part of it with common air will be a fatal mixture.

'It is also so insinuating and instantaneous in its effects, that a person inhaling it would fall down instantly dead, without premonitory symptoms of any kind, and without a chance of recovery.

'It is the presence of this gas which causes the peculiar unhealthiness arising from shores, river deltas, and mangrove jungles of tropical Africa. The miasma or noxious quality imparted to the atmosphere by stagnant water and decaying vegetable

matter is in reality a subtle poison, which acts on the human system through the medium of the lungs, producing fevers and other epidemics. All marshes and low damp grounds of every kind produce more or less miasma, and it is consequently dangerous to live upon or near them.

'The following is a test for sulphuretted hydrogen:—Write on or wet a slip of paper with a solution of sugar of lead, and while still wet expose to the atmosphere. If sulphuretted hydrogen be present, even to the amount of one part in 20,000, it will be at once detected by the browning or blackening of the solution of lead.

'The atmosphere varies at different elevations, the pressure on the mercury of the barometer diminishing as we ascend in height. By an elevation of temperature the capacity of the atmosphere to absorb and sustain moisture is increased, and by a lowering of temperature decreased. A consideration of these effects tends to explain the remarkable influence which change of climate has upon the human constitution. The inhabitants of countries possessing a light dry atmosphere are generally more lively than those of countries with a heavy, moist climate. The driest climate in Europe is Provence, in the south-east of France.

'Mr. Luke Howard's observations prove that London is warmer than the country; it acquires and loses its heat more slowly. The mean annual temperature of London is 59° 39′, being one-and-a-half degree above that of the environs. Limestone hills

also tend to diminish the humidity of the atmosphere. On the other hand, water and luxurious vegetation influence a climate in a very material degree. Dryness, a free circulation of air, and a full exposure to the sun, are the material circumstances to be attended to in choosing a residence. Houses in confined, shady situations, with damp courts or gardens, or standing water adjoining them, are unhealthy in all climates and seasons, more especially in a country subject to intermittent fevers, and during summer and autumn. The source of this fever is often traced to the flat ground on the banks of rivers. It may be observed here that a healthy condition of the digestive organs is the best state of the constitution to overcome disease. The human constitution admits of a more vigorous degree of health than that usually enjoyed by persons living in damp or confined situations. Dyspepsia, with its headaches, nervous irritability, languor, and depression of spirits, are some of the evils resulting from a residence in unhealthy situations. A removal to a more elevated situation, and a drier, sharper, and a more bracing air, affords a speedy relief. A moist relaxing atmosphere disagrees with persons of a torpid or a relaxed habit of body, and of a gloomy, desponding state of mind; while, on the other hand, a keen, bracing, dry air proves favourable in some cases of chronic intermittent fever. The genial influence of a mild climate is one of the most powerful means of relief which physicians possess for a broken-down constitution.

'No tall evergreen shrubs and large trees should be planted within the distance of several yards of houses where the occupants wish to keep their health; and no tree that, under any circumstances, grows higher than the building itself should be planted within twelve yards of it, as they are not only direct causes of impure humidity, but they act still more injuriously by preventing a free circulation of air and the entrance of the sun's rays. If, however, trees are desired near a house, then the oak, yew, and Lombardy poplar, are the most proper, as they attract lightning more than any other trees, and they will therefore act like so many lightning conductors to it; and as water and damp places serve as conductors of electricity it follows that all detached houses on clay soils should have lightning conductors affixed.

'The over-wooded state of many of the private parks of this country, especially in a flat district, is a fertile source of ill-health and disease, causing bowel complaints, rheumatism, and fevers.

'Draining will remove the water, which consumes the heat of the sun, and allow the air to pass into the interior of the soil and to the roots of plants. Water chills the soil about the roots; therefore, with a dryish soil the young plants are supplied with the gases required to promote their growth, and they can also better assimilate the mineral particles, such as potash, lime, silica, &c., that exist in the soil, for the purposes of their growth. If we walk at night in the neighbourhood of undrained fields, the air

hangs about our faces like a damp cloth; but if the land be drained this will disappear, as also the growth of aquatic plants, such as rushes, &c. In consequence of the extensive drainage in Aberdeenshire, the crops ripen ten or fourteen days sooner than they formerly did. The thermometer marks a difference of several degrees between the temperature of the soil in a field which has been thoroughly drained and one which is lying neglected beside it. An extensive system of drainage will, therefore, enable us to enjoy some of the advantages which other countries derive from a warmer sun. Our undrained fields are rendered cold, and the harvests in several districts are retarded by the excessive moisture of the soil—the rays of the sun, which should ripen the crop, being expended in converting the surface water into vapour. Fens, bogs, swamps and morasses may be considered as synonymous terms; there is really but little distinction in their characteristics, and no difference in the effects their moist and impure exhalations produce in the human health. The malaria fevers of Rome, both in their origin and characteristics, are exactly of the same nature as the fevers which are so common in the fens of Essex and Lincolnshire, increasing only in severity as the air increases in temperature.'

The human system possesses great capabilities of resisting disease, and has stored up in all its organ a surplusage of power which enables the functions of life to be carried on under circumstances which would at first appear to be impossible. All that is required

to render most trades and occupations in which men and women are engaged bearable and uninjurious to health is that the workers should be allowed sufficient pure air to breathe, pure water to drink, and that they should have secured to them a pure atmosphere in which to dwell when unemployed.

We might fairly estimate that if the people could have secured to them pure air and water, that the average duration of human life would be increased by nearly nine years, and the average amount of sickness would be reduced by rather more than twenty-five per cent. By the realisation of these two results a great portion of the burden of the present poor-rate would be saved, and a large addition to the producing power of the nation attained. It has been demonstrated in the previous pages of this work that impure air and impure water are the two chief factors in producing *preventable* disease. It has also been proved that an effluent water of comparative purity can be obtained under every circumstance and condition, fitting such water to be returned innoxious into the rivers and sea; and that solid sewage may be deodorised and disposed of in such a manner as to find a use for it, instead of leaving it to poison the atmosphere in which we live. The numerous side issues which grow out of the consideration of the two main questions of the supply of pure air and water have received such careful consideration in our previous chapters that it seems hardly necessary to make further allusion to them here. It cannot, however, be too often or too

forcibly expressed that the great difficulty in the way of an improved sanitary condition is the disposal of sewage. As regards domestic sewage, where a village or district is supplied with a proper system of sewers, and where the supply of water is constant and sufficient, water will continue to be used as one of the best methods of carrying away domestic sewage. Few villages or country districts are, however, in the possession of an abundant supply of water, or of a large-hearted man like Archdeacon Denison to store it for their use.[1]

In villages and remote districts, where water-works do not exist, and where there is not a good supply of water, the dry earth system will be found to be the best and cheapest method of removing *solid excreta*. The slop water and liquid sewage will, of course, remain to be disposed of by one of the three methods mentioned below. To the Rev. H. Moule is due the great credit of having introduced the dry earth system into modern use. When the use of earth-closets is accompanied with *an efficient system of scavenging*, it offers a most satisfactory solution of the question of the removal of fæcal matter in rural districts, for it is applicable to the most isolated as well as to the largest communities. This system is carried out most successfully on what may be termed a model plan, upon Sir Anthony Rothschild's estate in Buckinghamshire. The earth closets are supplied to 175 cottages and three schools. Two men, and a horse and cart, are

[1] *Times*, April 5, 1876.

employed the whole year round in attending to them; one man collecting the earth and carrying it to and from the cottages and the drying kiln, the other in preparing and drying the material. The kiln floor is over a retort at a private gasworks, and therefore the fuel costs nothing; and as to smell, so complete is the deodorisation that nothing offensive can be detected. About 200 tons of earth are required annually, which is dried twice over, and yields about 120 tons of excellent manure. To carry out this system satisfactorily it is absolutely necessary to employ proper scavengers; it would never succeed if left to the occupiers of houses. The manure, however, is said to be of sufficient value to more than cover the cost of the men and materials employed.

The conveyance of sewage from the dwelling is only part of the question; where to convey it and what to do with it are difficulties which have hitherto been only partly surmounted by science. To obtain a satisfactory effluent water has been the chief aim and object of all the great workers in this important and useful field of labour. Intermittent downward filtration, irrigation, and precipitation are the three methods which at present appear to offer the best results. Many districts are fighting this difficulty in a truly Spartan spirit, worthy of all emulation. Two most important reports have been issued while these pages were passing through the press;[1] and if, as we

[1] Colonel Ponsonby Cox's *Report on the Thames Valley Drainage*, January 11, 1876. *Report of the Utilization of Sewage Committee of Leeds*, February 29, 1876.

hope to see before the close of the present session of Parliament, a law is enacted that 'the rivers shall not be polluted,' so great has been the advance recently made in this branch of scientific investigation that we have no doubt a satisfactory method for the disposal of sewage will be found available for every village, hamlet, and mansion throughout the land.

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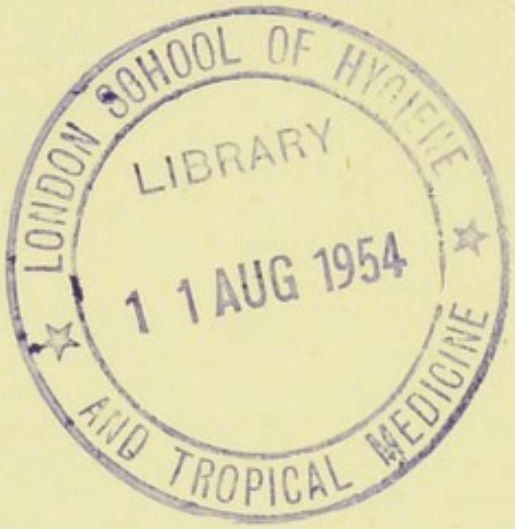
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