

RURAL WATER-SUPPLIES.*

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WHILE the conditions of life in cities and great towns, and the sanitary problems they present, necessarily absorb much of our attention, the significance of the rural districts in relation to the health of the community as a whole is not, perhaps, sufficiently emphasized. We do not always seem to recognise fully the immense importance to the urban populations of the sanitary condition of the rural districts, and the arduous and responsible nature of the labours involved in their charge.

The cities and towns overflow their boundaries, and suburbs of workmen's dwellings and of better-class houses spring up under the sanitary supervision of the rural authorities. As locomotion is quickened and cheapened, the urban populations will go farther afield at night, for in the future distance will be measured by time rather than by miles. Many of the rural areas contain considerable, some of them very ancient, towns, and half-grown and embryo towns, and rising watering-places and health-resorts, and large and small agricultural villages, all of which present their own, often very difficult, problems. The whole population, urban and rural, is largely dependent upon the country districts for their food-supplies, of which, milk, vegetables, fruit, and what are known generally as dairy produce, form such a large proportion; and shell-fish are collected along the coasts and estuaries and creeks of rural districts, and sent into the towns for consumption. The sanitary administration of the rural authorities should therefore be of the highest interest, for upon its efficiency depends to a large extent—to what extent we cannot know—the protection of the health of the whole of the people in the present, and the proper development of the towns in which will dwell so many thousands of the population in the future.

If there be one factor of the many factors of sanitation more dominant than another in a rural sanitary district, it is that of water-supply, and it is upon the subject of rural water-supplies I propose to address you.

The sources of supply vary in different districts and in different parts of the same district, sometimes within very narrow limits.

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Surface Supplies.—Many dwellings in the country, even farm-houses, are dependent entirely upon rain water collected from the roofs. Rivers, streams, rivulets, land-drainage, ponds, ditches, shallow dip-holes in the Drift, or alluvial sand and gravel, are examples of sources of surface supplies.

Wells.—Surface soak-wells, wells sunk to a water-bearing stratum, and deep wells are those usually found.

Springs may be divided into springs from the surface-drift and alluvium, and springs from the older rocks.

Speaking generally, surface-supplies liable to contamination furnish the large majority of the rural population with water, while a comparatively small minority are supplied by springs from the older rocks and deep wells not liable to pollution, either directly or by means of public supplies in the rural parishes, or by extension of the urban water-mains into the rural districts.

The origin of the supplies is in the rainfall. Reaching the earth as rain, which it for the most part does, it sinks into the soil in proportion to its porosity. If it falls faster than it can be absorbed, it runs off to the watercourses, or accumulates on the ground. The extremes of permeability are sand and gravel on the one hand, and clay and igneous rock on the other, and there is every degree between. If there are crevices and fissures in the subsoil-rocks which lie near the surface, or if the rock itself is exposed, the water rapidly passes away.

Much of the land in some parts is covered by Drift or Alluvium, recent formations which are usually very porous and sometimes of great thickness. They consist of sand and gravel and larger débris of older rocks. The water is held up in them by beds of clay at quite shallow or varying depths, and is made use of for supply.

Water-bearing Tertiary rocks may be at the surface or at considerable depth beneath it. For example, the Bembridge Limestone, in which the water is held up by the Osborne Clay, where it exists, is often a most useful source of domestic supply. The Headon Beds and Upper Bagshot Sands, in which the water is held up by the Barton Clay, and the Bracklesham Beds and Lower Bagshot Sands, in which it is held up by the London Clay, are deep sources of water-supply. In some Tertiary districts the clays cover miles of the surface, and the bulk of the water-supply is obtained from pockets filled with sand and gravel.

The Chalk at the top of the series is the great source of public water-supply among the Secondary rocks in many districts, and especially in the South of England, where it is at the surface. In some parts of the formation the water circulates in great

fissures, descending to saturate the Upper Greensand, beneath which the Gault Clay stops its progress. The Chalk may be denuded away, leaving the Upper Greensand to receive the rainfall directly; or by denudation the Gault may be exposed over wide districts, in which the absence of wholesome water is a great sanitary difficulty. Similarly, the Gault may be removed, leaving the Lower Greensand exposed, in which the water is held up by the Weald Clay. Or the Lower Greensand may have disappeared and the Wealden be at the surface, forming a large waterless area.

In one rural sanitary district twenty-one miles long and sixteen miles broad at its widest part, all the conditions described are present, and water-supplies are obtained from each of the formations indicated.

Below the Lower Greensand the Oolitic rocks hold abundant water: in the Upper Oolite, held up by the Kimmeridge Clay; in the Cornbrash, held up by the Oxford Clay; and in the Lower Oolite, held up by the Lias Clay. In the Marlstone series between the Upper and Lower Lias is a copious supply, and the same may be said of the New Red Sandstone and Magnesian Limestone. Below the Coal Measures in the Old Red Sandstone there are porous water-bearing beds of considerable thickness. But the lower Primary rocks, the Silurian and Cambrian, afford scanty supplies, and the discovery of underground water in the unstratified rocks is very uncertain, as it makes its way by fissures, the direction of which cannot be traced.

The water falls, and it is immaterial whether it be rain, dew, or has other atmospheric sources; and if the land be absorptive, it passes slowly down from particle to particle, carrying organic impurities with it—which undergo chemical change and ultimately disappear—until it reaches an impermeable stratum, and it is then stored up at greater or less depth beneath the surface in some such reservoir as those just mentioned. These are not like artificial reservoirs, for in obedience to gravity, pressure, and other forces the water circulates, moving along the lines of least resistance, and sometimes under pressure rising again against gravity. Should it reach the surface above the impermeable stratum, as on the side of a valley which has cut the formation across by denudation, it issues as a spring. The spring may simply be the overflow of a natural reservoir, as in the Chalk where the tilted Tertiary Clay lies against it, and the water flows out over its lip or edge.

The water carries down with it, of course, impurities lying beneath the surface, and also if the pervious bed be of no great

thickness, it may not be decomposed and rendered innocuous. I have said that some rocks are much creviced and fissured, and some are channelled and hollowed. In districts where these exist it is within the experience of most that great efforts are made when forming a cesspit to find an opening in the rocks (a fissure in the chalk, a crevice in sandstone or a channel hollowed out in limestone) and there are many instances of sewage containing disease-germs being carried long distances practically unchanged to water-bearing strata, and causing outbreaks of such diseases as enteric fever, the water being in such large volume that chemical or bacteriological analysis failed to detect impurity.

Such examples emphasize the importance of adhering strictly in rural districts to the sanitary test of wholesome water, which is the only reliable test : water free from the possibility of contamination by the poisons which produce disease. I do not wish to minimize in the slightest degree the value of water-analysis. It has its own very important place, and especially as regards the mineral constituents of water. But it is not *the* test of wholesome water, and it does not usually apply until water at risk is already poisoned, and then, perhaps, mischief is already done. Moreover, water may be potent for evil, and the methods neither of the chemist nor the bacteriologist may be able to appreciate the fact. I remember an epidemic of enteric fever in which there were four or five hundred cases and a mortality of 10 per cent. Spot-maps pointed out the public water-supply as the source of the poison. The chemists declared it an excellent potable water quite free from organic impurity, and the bacteriologists pronounced it so pure that it contained only 150 micro-organisms to the c.c., not one of them pathogenic. Drop samples were taken and examined, with the same result.

Now, the sanitary test had often been applied to this water-supply, and the conditions did not satisfy it. People were advised to boil the water before drinking, and many did so ; but the analyses were fluttered in the eyes of the public, and dazzled them. The water was pumped from a new tube-iron well sunk into the Chalk. Into this new well flowed the water from the old stone-steined well. There were ancient leaking cesspits within a couple of hundred yards from this well, and it was discovered a stone of the steining had been displaced, and through the gap came a perennial stream from the neighbouring millpond. No wonder they had an abundant water-supply. A fortnight or so after the communication between the two wells was severed fresh cases ceased. People who drank from the millpond and the stream which fed it did not get enteric, which may be explained, perhaps, by the fact

observed by Dr. Percy Frankland, that river-water containing millions of micro-organisms to the c.c., in which a part of the stool of an enteric fever patient was placed, did not produce the disease after five days, whereas deep-well water containing 150 micro-organisms to the c.c., similarly contaminated, produced enteric fever after thirty-five days.

As I have already said, the rural populations are largely dependent for their water upon surface-sources of supply, the majority of which probably would not satisfy the sanitary test of wholesome water. But to a large extent their use is inevitable, and there only remains to adopt the most stringent methods available to secure the greatest amount of protection possible. In almost every rural district one would expect to find some dwellings dependent upon rain directly for water-supply. Apart from certain dietetic considerations, rain-water, if properly collected and stored, is not an undesirable drinking-water, and it is, of course, the best possible for household purposes. But how rarely is it thus collected and stored ! The desiderata are underground water-tight ventilated tanks of such ample capacity that overflow pipes are unnecessary when the house is occupied ; some mechanical arrangement for rejecting the first water, which contains the washings of the roofs and gutters, if possible ; the discharge into capacious covered gullies in which much of the foreign matter will be deposited, which have overflows into the first chamber of a filter divided by slates, which reach nearly to its floor, and filled with natural filtering material, sand, grit, layers of gravel graduated in size, chalk and larger stones. The water passes down one section of the first chamber and rises up through the second section, from which it overflows into the first section of the second chamber, and finally into the tank or reservoir, the number of chambers necessary being determined by the quality of the water when it reaches the tank. The catch-pit should be cleansed weekly or oftener if necessary, and the filtering material should be renewed at least once in six months. While a certain number of householders even among the peasantry will attend to their water-supply arrangements perfectly, the majority neglect them, and rain-water supplies are usually abominably unwholesome. In the present state of education and intelligence of the people, efficient sanitation in rural districts involves automatic arrangements.

Rivers and perennial streams not only provide water for all purposes to those living on and near their banks in many districts, and in dry summers in clay-districts to man and beast for miles round at great cost, but they are frequently made use of for public

supplies. Rivers and streams are the natural drains of a country, and if that country be highly cultivated or populated, a large amount of sewage and filth containing the poisons which produce disease must find their way to them directly or indirectly. And when one considers what large populations make use of them for drinking, dairying, and every purpose, we can only suppose that greater evils than those we know of, such as widespread outbreaks of disease, do not more frequently occur, because of the absence of cholera from the interior of this country, and because the toxins produced by the myriads of beneficent micro-organisms which their waters contain destroy the pathogenic microbes which find their way to them. For public supplies river-water is filtered, but one cannot be blind to the risks as one observes the weak links which might, and sometimes do, give way. I connected outbreaks of sickness in a rural district some years back with the so-called cleansing of such filtering-beds, and found it was considered necessary because of the accumulation of a jelly-like mass over them. This jelly contained a vast mass of microbic life. Since the beds have been left alone these epidemics have ceased. Any effective private treatment it seems impossible to apply generally, and we have to fall back upon boiling the water for drinking; but in connection with dairy-work this precaution is too universally neglected, and it is no uncommon thing to see dairy-vessels being swilled out in the convenient stream or river, which may be not far below the intake of the farmyard drainage or the mouth of a sewer.

The smaller streams are used and fouled by cattle; they receive the drainage of farmyards, and in the best cared-for districts cesspit-overflowes are surreptitiously carried to them, not infrequently at night. In villages on clay they are the only source of water-supply apart from rain-water, which cannot be collected from thatched roofs. In dry seasons they may cease to flow, and the water is dipped in meagre quantities from muddy holes in their beds. The mud is allowed to subside in the buckets, and the supernatant water is ladled from them, or run off into other buckets, tubs, or pans. Any rain-water stored in the usual small tanks has been long since exhausted, and the dairyman or market-gardener, under the pressure of business, may not be able to wait for the muddy water to clear even. The admonition to boil the water for drinking may not be heeded, but in many villages in the South of England the cottagers drink weak tea at every meal, a large brew being made for the children to take to school and the husband and elder boys to work, as well as for use at home between meals.

Rivulets on the hillside, especially if near the spring, are useful. They are easily managed. Little reservoirs are sometimes made by the cottagers on their course, from which they dip, or from which the water is piped to a lower level, and the farmer may pipe it to troughs for his cattle, and turbines throw it possibly to the tops of country residences, but very seldom to a farmhouse. It is often worth while to look after such supplies, and much may be done at little cost.

An agricultural drain-pipe projecting through a bank and discharging into a ditch water from land-drainage is a boon to many a cottager, and as the pipes are laid at a good depth to avoid the plough, the water, though possibly liable to contamination, is not necessarily unwholesome, and it is often soft.

In some parts of the country ditches, especially in clay districts and in times of stress, are much resorted to. They are very liable to pollution, particularly near dwellings.

Ponds are sources of water-supply in some sections of almost every rural district. They are subject to pollution. Cattle usually drink from and foul them. Having regard to milk-supplies, there is one universal pond which demands attention: that which receives the drainage of the farmyard. The British farmer insists it must be right for the cows, as they like to drink the water more than any other, he supposes because it is drink and meat at the same time, and if the milk is not flavoured by it, he cannot see that it matters.

Dip-holes are shallow wells or depressions in water-bearing ground. The water is held up by clay not far beneath the surface, as where the Upper Greensand is thinning out over the Gault, or sand and gravel fill a pocket in the clay. Although liable to surface contamination from dirty buckets and in various ways, some of these dip-holes, when situated in the corners of permanent pastures and protected from cattle, are far less objectionable than dip-wells in cultivated gardens.

Wells are the chief sources of domestic water-supply in most rural districts. The majority are surface soak-wells, and in the agricultural villages they are usually dip-wells in vegetable gardens highly fertilized with pig and human manure. They are loosely steined with brick or stone, and their heads are not generally raised above the surface of the ground, although they may have covers for the protection of the family in another sense than from contamination of the water. Houses of a better class are often situated on gravel, plateau gravel, or gravel contained in pockets of the alluvial clay. They have similarly constructed wells, but they are sealed by pumps. The houses drain into cesspits also

loosely stained. The sewage is supposed to soak out of the cess-pit and the water into the well, but as a matter of fact the sewage and water stand at the same level in the respective wells, the level of the underground water, or, in other words, the houses drain directly into the reservoir from which the water-supply is drawn. When the underground water-level is at some depth below the surface in country villages, the wells are somewhat less liable to pollution, if only because the water is raised by means of a windlass and the same bucket lifts it. If the underground level is below 28 feet, this is the universal method of drawing it in many parts, for force-pumps are not often met with. If it be at considerable depth, a public well often serves the village-community, the water being laboriously raised by windlass. In such districts the farmsteads depend upon the same method, great economy in the use of the water being observed to save labour. These deep wells are not infrequently found to have become contaminated in the course of ages. In many of the villages, and not a few of the towns in rural districts, there are public pumps to which the people go for their drinking-water, that in their private wells having gradually become too nasty to drink. It is not unusual for the public wells to be closed one after another for the same reason, the subsoil having become more and more polluted as population has become crowded. In many rural districts now the deep tube-wells to reservoirs hundreds of feet below the surface are coming into use for domestic as well as for public supplies.

Often one of the most difficult questions to decide in a rural district is the advisability of closing wells. The well-water in a populous village may either be already contaminated or in imminent risk of contamination. To close the wells would be to cut off the water-supply and to drive the people to even more dangerous sources. The decision taken must depend upon the circumstances, but greater security may be generally obtained by reconstructing the wells. If the well be of moderate depth, the upper 6, 8 or 12 feet, as the case may be, of the brickwork should be rebuilt in cement, and should be surrounded with 9 inches of well-puddled clay or concrete, which is better. The head should be raised above the surface in concrete, or brickwork in cement, covered with concrete, and a pump fixed. For shallow wells concrete should be used throughout. Driven tube-wells, however, are safer and more economical. In reconstructing deep wells, the precautions taken will depend greatly upon the nature and porosity of the surface-beds through which it passes. It may be more economical, and often it is more satisfactory, to drive or bore a new well, the means

for doing which are much improved. Trouble is sometimes experienced in these wells from the wearing of the pumps by sand, as when they are sunk to the Bagshot Sands, the great water-bearing beds of the Tertiary rocks. This may be obviated by the use of the air-lift pump.

But although very much may be done to increase the comparative safety of wells and other sources of rural water-supply, and although as regards new buildings we have it entirely in our own hands to refuse the water-certificate if the sanitary test of wholesome water be not satisfied, even if we are not supported by bye-laws, which we should be, our best efforts will effect far less than we could desire. It has long seemed to me there is but one method by which the health of the dwellers in rural districts, and indirectly of the urban populations, can be satisfactorily secured in connection with rural water-supplies, and that is by having independent public supplies. By obtaining such supplies we do far more than give the people wholesome water to drink: we increase enormously the use of water for domestic, dairy, and other purposes which affect the interests of the public health, and we effect an incalculable economy of labour and time, saving the money they represent, for turning a tap is a very different thing even to pumping from a well. If this saving could be calculated in pounds shillings and pence, it would be found, probably, that an independent water-supply in many rural parishes would cost nothing. A £2,000 gravitation-scheme would cost £100 a year for sinking fund and interest, and another £10 for expenses would probably cover the annual outlay. If the water-rent did not meet this charge the balance would not be appreciated in the rating, and if they exceeded it the credit-balance would help the rates. But such considerations are scarcely appropriate, for the community must expect to pay for their protection.

The simplest method of obtaining a water-supply for a parish is to go to the head of a perennial stream, high up on the side of a hill if possible (for a gravitation-supply is, of course, the most advantageous) to collect the water as it leaves the rock in a sufficiently large reservoir for the needs of the population, and pipe it through the parish. If some of the water-bearing strata are at the surface in such a position, as, for example, the Upper Greensand, in which the water is very evenly distributed, it may be necessary only to drive an adit into the hill a few feet above the impervious stratum to obtain sufficient water. If the Greensand is below the surface and the Chalk above it, the water may be obtained in a similar manner, but the strong Chalk-springs often issue at a considerable elevation.

If a gravitation-supply is not practicable, it is necessary to pump to a height from which every house in the parish may be supplied. If there is no commanding hill, a water tower must be built. Assuming it is necessary to go beneath the surface to no great depth, an iron cylinder well must be constructed from which to pump. If a sufficient quantity of water can only be found at a great depth, it may be hundreds of feet down, a tube well must be driven or bored.

In a non-gravitation supply, if the water issues at the surface in sufficient volume, it may be possible to raise it by ram or turbine. If not, or if it is beneath the surface, a wind-pump is the most economical means of raising it, and if the reservoir has ample storage-capacity it may be sufficient. Or an oil- or gas- or small steam-engine may be used, but this would increase the annual charge, which is a consideration in a purely agricultural parish.

If I were asked how a medical officer of health may be enabled to indicate to his authority the existence of a porous stratum in which enough water is held up, by a bed of clay or other non-permeable rock, to supply the population of a particular parish or combination of parishes—and the cost is less if parishes can be combined for purposes of water-supply. I should say every medical officer of health of a rural district should be a geologist. I do not mean that he should necessarily be learned in geology or be a practised palæontologist, but he should be familiar with the elements of the science, and be acquainted with the leading facts of physical geology. Then with local knowledge, the aid of the Drift map and the sections of the district of the Geological Survey, and, “when needful, the help of a competent geologist” (such as my friend and our brother member Mr. W. Whitaker, F.R.S.), he would not be likely to lead his authority astray.

Gentlemen, in place of narrating to you the results of any special investigations I may have made, I have preferred, as your President, to bring before you, if inadequately, a practical subject which is of momentous concern to each one of us, for it affects very closely the interests of the public health, the guardians of which we are. But although it is common to all of us, I felt when choosing a subject appertaining to rural administration something of sympathy and encouragement would be conveyed to some among us whose labours are least known, who are struggling in the face of adverse influences to do their duty, and who have no possible recompense but that of an approving conscience. As a class, medical officers of health have many disabilities and great responsibilities; our work receives

little recognition : we are even denied the means of making it more efficient, but we have our compensations. I sometimes think that a man who, in the presence of strong opposition and contumely, perhaps knowing that he risks his chance of reappointment, is the means of securing to the people of only one parish the blessings of an independent water-supply, has not lived in vain.

THE TREATMENT OF SMALL-POX.—R. B. Sandall, from his experience in the Philippines, believes in the practice of opening the pustules freely. He would use antiseptic baths from the very beginning, and keep the skin as nearly aseptic as possible. As soon as the spots became vesicular, open the top and remove all contents, applying antiseptic solution to the whole open surface. The pustules, after they have formed, should be treated in the same way, and the skin kept free from pus. The vesicles, once thoroughly opened and destroyed, do not proceed to pus formation, and absorption of the poison is avoided.—*Journ. A. M. A.*, July 11th, 1903.

FIRE HYDRANTS A SOURCE OF WATER POLLUTION.—Attention is drawn in the *Sanitary Record* (December 18th, 1902) to a practice of water companies and local authorities owning water-supplies of fixing fire-hydrants in public roadways, in chambers which are almost universally built in rough brickwork, and which are generally to be found in a filthy condition from the surface washings of roads. Frequently, too, they are found to be connected to road gullies and sewers so as to drain off the water. These hydrants, especially of the patent class with ebonite ball, readily admit the foul water from the chambers or pits in which they are placed, and, when the mains are temporarily emptied, such foul matter is inevitably drawn into the water mains. It is very desirable that, as regards both hydrants and air-valves on water mains, they should be effectually protected in water-tight chambers, so as to insure that public water-supplies are no longer dangerously polluted through them.

THE IMPORTANCE OF GOOD BREAST MILK.—It has for many years been an accepted fact the world over that the mortality of infants who are fed on good human milk, obtained from their mothers or other healthy women, is lower than that achieved by any other method of feeding. It should, however, at once be insisted on that experience has also shown that it is good human breast milk, and good according to the modern sense of the word, which has produced these results. Poor milk from human beings, poor because it contains inadequate percentages of the various elements of the milk, such as the fat, sugar and proteids, or because of the improper combination of these elements, can, as it has often been proved, produce diseases, especially those which are connected closely with nutrition. The most common of these diseases are rachitis, infantile atrophy, infantile scorbutus, and the various gastro-enteric disturbances, which not only lead to malnutrition, but also render the infant vulnerable to specific diseases caused by specific organisms.—T. M. ROTCH, *American Medical Journal*, xli., No. 6, August 8th, 1903.