

Dr. S.W. Wheaton's report to the Local Government Board on enteric fever in the Swanage Urban District in 1910.

Contributors

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REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(NEW SERIES No. 47.)

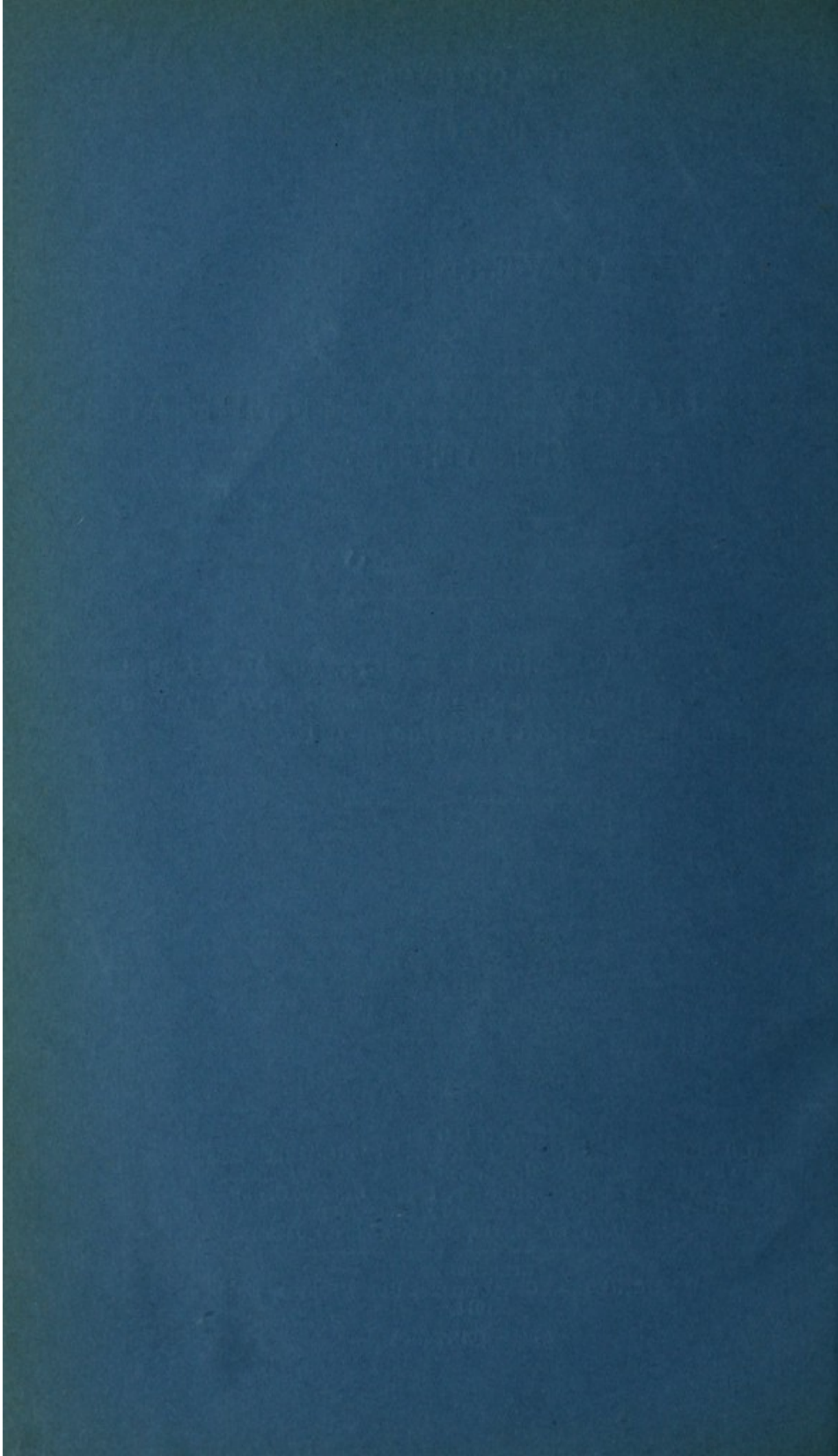
Dr. S. W. Wheaton's Report to the Local
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Dr. S. W. Wheaton's Report to the Local Government Board on Enteric Fever in the Swanage Urban District in 1910.

ARTHUR NEWSHOLME,

Medical Officer,

11th January, 1911.

The Swanage Urban District is situate in the county of Dorset and comprises the town of Swanage together with the village of Herston and some small hamlets. The area of the district is 2,659 acres. The population in 1901 was 3,408; in 1891 it was 2,631, and at the present time it is estimated at 4,100 persons, living in 1,091 houses. In summer time the population is greatly increased by influx of visitors. Formerly the sanitary condition of the district and the sanitary administration of the urban district council were very unsatisfactory. In 1886 a very serious outbreak of enteric fever occurred which was reported upon by Mr. W. Harvey, then temporarily acting as one of the Board's Medical Inspectors. Mr. Harvey attributed this outbreak to the prevalence of unwholesome conditions, and after his visit certain recommendations were made to the then Local Board for the improvement of the district. In 1893 Dr. Bulstrode, one of the Board's Medical Inspectors, visited Swanage, and made certain recommendations to the urban council for the sanitary improvement of their district. Very little result followed these recommendations however, and in 1897 I was instructed to visit the district, and inspected it.* I found at that time that there were many dilapidated and damp dwellings, that the surroundings of the Park Road well, occasionally used as a source of water supply, were unsatisfactory, that although £6,000 had been borrowed for purposes of sewerage, yet the outfall sewer proposed as part of the scheme had not been constructed, and the streams in the district and the foreshore of the public bathing places were polluted by sewage. I also found that, when the new sewers were laid, the old defective ones had not been removed, nor had the

* Dr. S. W. Wheaton's Report to the Local Government Board on the Sanitary condition of Swanage, and on Administration of the Swanage Urban District Council, 1897.

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connection of house drains to the new sewers been generally enforced, with the result that the sewerage of the place remained in an unsatisfactory condition. The drains of the older dwellings were commonly defective. There were a number of vault privies in use, and the scavenging of these and of ashpits was left to occupiers. The condition of slaughter-houses, and of dairies and of cowsheds was unsatisfactory. No register was kept of nuisances, and very little action was taken for the permanent abatement of such as were likely to recur. There was no hospital or disinfecting apparatus.

In 1899 an outbreak of enteric fever occurred comprising 25 cases, which was attributed by the medical officer of health to pollution of the milk of a certain dairy, by the use of polluted water from a well at the dairy farm, but the source of infection of this well water was not discovered. Since this date there has been little enteric fever in Swanage, seldom more than one or two cases yearly, and in some years none.

On September 13th 1910 a case of enteric fever was notified in the urban district and was followed by further notifications at intervals of a few days. On October 17th, up to which date six cases had been notified, the medical officer of health prepared a report which he submitted to the council, in which he said "that he did not think the water supply was to blame, but that the well at Park Road was in a position liable to contamination, and, having been already condemned by himself and by the government inspector, ought not to have been re-opened." On the 18th of October the council wrote to the Board saying that they had requested the water company to close this well, but that the company was reluctant to do so. The council asked that a medical inspector should be sent down to enquire into the matter. A deputation from the council also interviewed the Board's assistant medical officer on the 26th of October. I was accordingly instructed to visit Swanage and to make inquiry into the circumstances of the outbreak of enteric fever there. This I did on November 1st and following days.

I.—GENERAL SANITARY CIRCUMSTANCES.

The Swanage Urban District is oblong in shape, measuring 3 miles by $1\frac{1}{2}$ miles. Its greatest length is from north to south and includes the coast line from Anvil Point nearly to Ballard Point. The southern half of the district consists of land rising to an elevation of 400 feet, the northern half is formed by a valley which opens out to Swanage Bay, and which increases in elevation northwards where it is bounded by the chalk downs. Two small streams traverse the valley and fall into the sea. The old town of Swanage was situate at the junction of the steeply rising southern hills and the lowest portion of the valley, and the larger of the two streams, which in part has now been bricked over, passes through this portion of the town running nearly parallel to the High Street. Newly built dwellings have extended over the southern slope on the Durlston Estate, also in the valley between the two streams, and to the north of the northernmost stream on the Cliff Estate. The subsoil on the southern elevated portion of the district consists of clay and decomposed rock, resting on the Purbeck beds of the Oolite series.

In the valley the subsoil consists of alluvium and of sands and clays of the Wealden formation. The hills on the southern slope are honeycombed with old underground workings, from which the Purbeck marble and Purbeck stone were formerly obtained in large quantities, and which furnished employment to the inhabitants in former years. These workings are now however in great part disused and the inhabitants depend upon catering for visitors, who come to the town in large numbers for the sake of the stimulating qualities of the air from the neighbouring downs combined with the mildness of climate due to the proximity of the sea.

Condition of dwellings.—The old dilapidated dwellings which existed at the time of my former inspection in 1897 have now been almost entirely replaced by new buildings, and there is little fault to find with the general condition of dwellings in the district. There have been very few new dwellings built at the village of Herston, where there are 119 houses chiefly occupied by the working classes.

Water supply.—This is almost entirely furnished by the Swanage Gas and Water Company. This Company has four sources of supply. No. 1, the Park Road well or high level service, supplies about half the houses in the district, with a population which is probably about 2,000 persons. It serves the southern portion of the town, exclusive of the houses on both sides of the High street, and also serves 28 houses at the northern extremity of the district. The water is derived from a well with a boring at the bottom. The site of the well is 50 feet above Ordnance Datum, at the foot of the southern hill slope, a little to the south of the termination of the High street and 120 yards from the sea at high water mark. The well, which was made about 50 years ago is built with stone set in cement and extends to a depth of 60 feet, while the boring at the bottom of the well extends for a further 53 feet, making 113 feet in all. The water is raised and pumped by a steam engine to a reservoir of 200,000 gallons capacity situate at Durlston, from which it is distributed by gravitation. The well furnishes 100,000 gallons per diem.

With reference to the character of the water supplied from this well in my former report I stated that "the well is sunk upon a site which has been occupied by dwellings for many years, and is surrounded by dwellings at the present time. Since Swanage is an ancient town in which vault privies and cesspools so-called, have long been in use, allowing soakage of their contents into the subsoil, which at this part is composed of loose rock with many fissures, it is probable that organic filth has penetrated the rock to a great depth; and since the well is sunk in this fissured rock, there is risk that organic filth may get access to and contaminate the water furnished by it. The well in question appears to intercept water flowing from higher ground towards the sea. Thus I am informed that when the water is pumped from this well the level of the water in private wells in its neighbourhood is much lowered; and notably so in the case of a particular well situate at a lower level nearer the sea. It is evident that there are several underground streams making their way from the higher ground towards the sea in this part of the town." I also said "that the company would do well

entirely to discontinue" the use of this water. After my visit the company, on October 6th, 1897, gave the urban district council a written undertaking to cease using this water, but in 1901-2 they resumed its use and have since continued to use it up to the 22nd of October, 1910.

Sources Nos. 2 and 3 which constitute the low level service, are two wells sunk in close proximity at Ulwell, at the base of the chalk down which forms the northern boundary of the valley. These wells are situated at a level of 150 feet above Ordnance Datum and are 20 and 30 feet deep respectively. They are sunk in the chalk at its junction with the upper greensand and are intercommunicating. The water flows into the mains from the wells directly and is distributed by gravitation to the northern portion of the district, the northern half of the town, including both sides of the High street, the village of Herston, most of the dairy farms in the district, and the village of Langton Matravers, which is about equal in size to Herston but is situated in the Rural District of Wareham and Purbeck. There is a pumping apparatus at the wells, but it is not used. At the time of my former visit this source supplied the whole town, the pumping apparatus being then used to supply the higher levels through a reservoir but it is at present unprovided with storage, beyond what the wells will hold, and the higher portions of the town cannot be reached by the water from it owing to insufficient pressure. The water appears to be of good quality and free from risk of pollution. Source No. 4 has been provided since my last visit in order to supplement the other sources, and is employed only in the months of July, August and September. This supply was first used in 1908. It is derived from a well situated at South Barn on the hill at the southern portion of the district and is a little more than half a mile to the south of source No. 1. The water is pumped to the same reservoir as source No. 1 so that when this source is in use these waters are mixed. This well will furnish 7,000 gallons per diem. The site of the well is 204 feet above Ordnance Datum, in a shallow valley running eastward and terminating on the sea cliffs down which a small stream of water collecting surface drainage from it falls. The sea is considerably less than half a mile distant. The well is lined with bricks set in cement and reaches to a depth of 210 feet. From the bottom an unlined boring extends for a further distance of 270 feet making 480 feet in all, so that a depth of 276 feet below sea level is reached. The boring is said to reach the Kimmeridge Clay, penetrating both the Purbeck and Portland beds. Two adits have also been driven southwards from the well. The well is a little to the south of a well known fault, up to which the underground workings for stone have been carried. It is thus a short distance from numerous underground workings which, however, appear at present to be all disused. There is said to be no inflow of water until a depth of 140 feet from the surface is reached. This well resembles well No. 1, in that it is sunk in the Purbeck beds which consist of alternate layers of limestone, shale, and clay, and in its proximity to the sea. If building operations should extend in future in this direction, as they have been doing for many years, dwellings may come to be erected dangerously near

the well. The Purbeck beds are excessively broken up and disturbed, as can be seen in the adjoining cliffs, the limestone bands are much jointed and fissured ; the beds are well known to be liable to the development of pipes or gutters of large size leading from the surface into the deeper strata, down which water may enter directly from the surface. An attempt to obtain water a little to the north of the present well failed altogether. The land surrounding the well is arable, but it is stated that only farmyard manure is used for its tillage, and in fact only such manure was to be seen at the time of my visit. The subsoil is of clay overlying the rock. In dry weather this clay is well known to be liable to develop deep and extensive cracks, by which surface water would be admitted to the underlying strata, but after continued wet weather the clay expands, and all cracks being filled up the surface becomes watertight.

Owing to the development of these cracks in the clay surface water is especially liable to gain access to the water bearing strata in which the well is sunk during heavy rains following on a period of drought. The surface water will readily pass through the cracks before the clay, by imbibition of moisture, has swollen sufficiently to close them. If therefore the surface water should contain polluting material of a dangerous kind the underground water would in these circumstances be exposed to grave risk of contamination by such material. As a matter of fact the surface water in the neighbourhood of this well is liable to pollution of this kind since there is a farmstead 190 yards distant from the well with the usual cowsheds, stables and fold yard. The surface drainage from this farmyard and from the dwelling house flows to a ditch in an adjoining field 233 yards distant from the well. There is in the farmhouse garden a large pit privy, which is not watertight, and which at the time of my visit contained a large quantity of semi-liquid filth. A draw well, which formerly furnished the water supply has been disused since the introduction of the waterworks from which water has been piped to the farm. Its site was covered by a hayrick at the time of my visit, so that I could not examine it. There are six persons living at the farmhouse. A death has occurred there during the present year which was attributed to heart disease. If due regard be paid to the well known defects of the oolitic rocks as a waterbearing stratum, to the near neighbourhood of old underground workings, to the proximity of the town, and to the probability of its still closer proximity in the future, it would appear that this is not a site which should have been selected for a well. The surrounding area of untilled surface is also very inadequate in extent for the protection of the well.

The results of chemical analyses made by Messrs. Moore and Partridge, of Savoy House, W.C., on behalf of the water company, of samples of these four sources taken on October 7th, 1910, show no obvious organic pollution, the amounts of free and albuminoid ammonia, and of nitrates, being well within those of a water free from suspicion. The total solids and chlorine for the sources 2 and 3, 1, and 4, however increase in the order in which they are named from 19.0 grains of solids and 2.3 grains of chlorine per gallon, to 49.3 and 4.0, and 57.7 and 6.9 respectively. All houses

in the district are supplied from cisterns and there are hydrants in the streets, for fire and street watering purposes which are supplied from source No. 1.

Sewerage.—Since my last visit the outfall sewer has been completed and carried out to sea along a reef of rocks at Peveril Point. The old sewage outfall has, however, been retained as a storm overflow, and unfortunately it is in the worst possible position, in the most land-locked part of the bay. With this exception there is now no discharge of sewage on the foreshore. Connection of house drains with a sewer has been made in all instances where one is within a reasonable distance. All private sewers discharging on the foreshore have been removed, and pollution of watercourses in the district no longer occurs. There is, however, no detailed plan of the sewers, and the course and structure of some of them can only be guessed at. A number of the old sewers remain and are constructed of rubble only. The sewers are mostly of very steep gradient in the southern part of the town, but in the northern portion the fall is unfortunately very small. Ventilation of the sewers is carried out by means of iron upright shafts. The provision for flushing is very limited and consists of four tanks, one of which is supplied with the company's water, while the remainder are supplied with water from a well, pond, and stream, respectively.

House drainage.—Nearly all houses are now provided with properly trapped gulleys; sink pipes discharge over gulleys in the open.

Excrement disposal.—With the exception of less than a dozen pail closets, and a few pit privies, in the rural part of the district, the whole of Swanage is now supplied with water closets, which have a separate supply of water for flushing. Soil pipes are as a rule adequately ventilated.

Refuse disposal.—Refuse is collected in moveable receptacles, and removed thrice weekly to several tips, from which it is taken by farmers for use on the land.

Slaughter-houses.—These are two in number and one of them is registered. They are of fair construction and cleanliness, but numbers of pigs are kept on the premises, with the result in one instance, of causing great nuisance from decomposing pigs food. Under such circumstances freshly killed meat hung in the slaughter-house can hardly fail to absorb the foul odours and so to become tainted and liable to premature decomposition.

Cowsheds, dairies and milkshops.—These are registered. There are 4 milkshops and 12 cowsheds. The condition of the milkshops is good, that of the cowsheds varies. Of cowsheds some are very satisfactory, others are unsatisfactory. On the whole their condition is greatly improved since the time of my first visit. Water supplies for cows and dairies have been much improved. The principal defects are want of efficient ventilation and drainage, also overcrowding, and accumulations of manure in unpaved fold yards.

Bakehouses.—There are eight registered. Their condition appears to be satisfactory and they are now supervised by the urban district council's officials.

There is no common lodging house.

Only one registered midwife is employed in the district.

II.—ENTERIC FEVER IN SWANAGE URBAN DISTRICT IN 1910.

The first known case of enteric fever was notified to the medical officer of health on February 18th. The sufferer was a lady who had come to a convalescent home at the southern high lying end of the town on February 7th. This lady was thought to be recovering from ulcer of the stomach, but two days after arrival she was taken ill and removed to the cottage hospital, and after observation it was decided on February 18th that her illness was enteric fever. No relation between this and subsequent cases can be traced. No further enteric fever occurred until, on September 13th, the first case of the outbreak under notice was notified. During the period September 13th to 26th five cases were notified. There was then an interval of freedom from fever notifications until October 12th, when another notification was received, and from this date until October 29th eight cases were notified. On November 1st two more notifications were received, and from this date until November 13th six cases were notified. Thus 19 cases in all were notified during the period September 13th to November 13th. To these must be added five additional cases which were not notified in Swanage, owing to their having left the town before their illness, which subsequently proved to be enteric fever, was sufficiently declared. In all, therefore, 24 cases are known to have occurred in the course of the outbreak. Of these 24 cases 12 were visitors to the town.*

As regards 23 of these 24 cases I have been able to get sufficient particulars to fix the probable date of onset of the disease. This occurred in September in 11 instances, in October in 9, in November in 3. If an average period of 12 days be allowed for the incubation period of the fever in these cases the infection would have been received on the following dates :—

August 21	October 1
„ 21	„ 3
„ 23	„ 4
„ 26	„ 6
„ 31	„ 6
September 1	„ 7
„ 2	„ 11
„ 5	„ 21
„ 16	„ 24
„ 16	„ 26
„ 17	
„ 19	
„ 24	

* The actual number of persons who were attacked after a visit to the town could not be ascertained with certainty.

In addition to the 12 visitors known to have been attacked others are reported to have suffered from illness after leaving the town which might have been enteric fever. Owing to failure to trace these persons definite information as to the nature of their illness could not be obtained.

Of the 24 cases 9 were males, and 8 were under 13 years of age. I gathered from the medical practitioners in attendance that the attacks were mostly severe; an eruption was marked in all instances, intestinal hæmorrhage occurred in several, and up to the time of my visit two had terminated fatally.

III. CAUSATION OF THE ENTERIC FEVER OUTBREAK.

On marking the houses occupied by persons who had been attacked by enteric fever on a plan of the town it was seen, that with one exception, every invaded house was to the south of the line of the High street. When the plan was compared with the plan of the mains, which is kept by the waterworks company, it was also found that every invaded house was supplied with water from Park Road well, source No. 1, supplemented during July, August and September by source No. 4. This well supplies water to just about half the houses in the town, the others being supplied from sources 2 and 3, the Ulwell supply. The exception, a house on the north side of the town, was one of 28 houses supplied with water from source No. 1 by a special long main passing through the area of the Ulwell supply. The village of Langton Matravers in the adjoining rural district of Wareham, with a population of about 400 persons, is supplied with water from sources 2 and 3, as well as the village of Herston which is in the urban district. Both these villages as well as the area of the town supplied by sources 2 and 3 have entirely escaped fever. I was informed, however, by the waterworks company's officials that for a portion of August and September, a connection was made between the main conveying water of sources Nos. 1 and 4 and the main which under ordinary circumstances contains water from sources 2 and 3 only and which serves the village of Herston. This connection was made for two hours daily, but the actual dates when such a connection was made, and an estimate of the amount of water which would pass into the main supplying Herston cannot be ascertained. The connection was made in the middle of the day, after the cisterns had been filled from sources 2 and 3, with the object of keeping up pressure in the main. When the main containing the mixed water of sources Nos. 1 and 4 was connected to the Herston main the water from sources Nos. 2 and 3 was cut off and the actual connection was made in the town. After the valve in the town admitting water from sources 1 and 4 was opened, the water from these two sources would have to displace the water of sources 2 and 3 lying in a main nearly half a mile in length, and to which a few houses only are connected en route, before it reached the village of Herston. It is quite possible that water from sources Nos. 1 and 4 never actually reached the village, because it may have happened that when the valve restoring the water from sources Nos. 2 and 3 was opened at a point near the village the water lying in this main was swept out again. This was the more likely to occur because the main falls towards the town of Swanage and this water would tend to flow back by gravitation away from the village of Herston. The large amount of water constantly being drawn off in the town would also assist in emptying the Herston main of water from sources 1 and 4

remaining in it. In the absence of exact information as to how the valves were worked it is impossible to make a definite statement on this point, but in any case the actual quantity of water from sources 1 and 4 reaching Herston must have been very small, and it must have been greatly diluted with the water of sources 2 and 3 which supplied the village during 22 out of the 24 hours. In this way the entire escape of the village from fever may be explained. The population of the village is about 480 persons.

The entire restriction of the fever to the area which is habitually supplied with water from source No. 1, supplemented in July, August and September by source No. 4, afforded therefore presumption that the water of one or other of these sources had been concerned in the causation of the outbreak.

Nevertheless inquiries were made as to other possible causes of the disease. The question of infection from consumption of infected shellfish, from milk, or other foods, by emanations from sewers or through soakage from sewers infecting the subsoil, from laundries dealing with infected clothing, and from personal infection were each considered.

With regard to shellfish—I am informed that, with the exception of a few oysters practically no shellfish is sold in Swanage. The outbreak moreover began before the commencement of the oyster season. Whether shellfish had been consumed or not within a time which would render relation between such consumption and the subsequent development of the fever possible was ascertained as regards 21 out of 24 cases; with the result that such relationship could be definitely excluded in each instance. As regards the three remaining cases this information was not obtainable, because they had left the district, and accordingly the question whether they had consumed shellfish whilst at Swanage could not be decided with certainty.

On inquiry it was found that milk was supplied to the invaded households by all the principal milk sellers in the town, who are four in number. The number of infected families served by a particular milk seller were roughly proportional to the amount of his business. In the course of inquiry into the sources of the milk supplied by the various milk sellers, it was found that the milk of the farm implicated in the outbreak of enteric fever in 1899 was supplied to houses in the southern part of the town, including a large part of what may be termed the invaded area, which coincided with the area of the water supply from source No. 1. On further investigation, however, it was found that only three invaded families were supplied with this milk; that it was supplied to the village of Herston, near which the farm is situate, in which village no enteric fever has occurred; and that the water supply of the farm is now from the water company's sources, Nos. 2 and 3, against which there is no suspicion. As to sewers, there was no incidence of fever along the line of any particular sewer sufficient to suggest that the sewer had been a source of infection.

As to laundries, no laundry workers were affected, and there was nothing to suggest infection disseminated in this way.

With regard to the influence of personal infection, multiple attacks were limited to four households, and the number of sufferers did not in any case exceed two in the same house or the same family. In two of these families the first person attacked had been removed to hospital. There was no subsequent infection of families living in houses contiguous to those first invaded, and clearly contagion by personal infection had very small if any influence in the spread of the disease.

There did not appear to be any escape from the conclusion that the water supply of the area which is habitually supplied from the well source No. 1, and which was occasionally supplemented with water from well source No. 4, was the means by which the fever had been disseminated.

Circumstances of the distribution of water in the area supplied from sources Nos. 1 and 4.—Source No. 4 was resorted to in order to supplement source No. 1 on the 30th of June, and continued in use until September 29th, when it was discontinued. In consequence of the representations of the district council and the suspicion attaching to source No. 1, this source was in its turn discontinued on and after October 22nd, and source No. 4 was substituted and continued in use up to the time of completing this report.

I have already shown that persons attacked by enteric fever probably received the infective material of the disease during the period August 21st to October 26th; and it appears that the invaded area was supplied with water from sources Nos. 1 and 4 jointly from June 30th to September 28th, with water from No. 1 only from September 29th to October 21st, and with water from No. 4 only after October 21st. It becomes necessary therefore to consider whether there is any evidence which would tend to incriminate one of the sources more than the other as having been the agency by which the fever was disseminated. In this connection it is noteworthy that the outbreak of enteric fever followed upon the introduction of water from source No. 4. The importance of this consideration, however, is lessened by the fact that no infection occurred until seven weeks after No. 4 supply came into use. Furthermore, there were no less than eight infections in the period September 29th to October 21st, during which source No. 4 was not in use, a fact which tends to exonerate that source as an agency of infection. It is true no doubt that if this water were infected the infection might have persisted in the house cisterns, mains, and reservoir, for a short time after the supply from source No. 4 was cut off, although this water must have been diluted to a very great extent by that of source No. 1, which was present in the proportion of 100 to 7 of No. 4.* On the other hand, two cases appear to have contracted infection on October 24th and 26th, although the water from source No. 4 only was in use in the invaded area after October 21st. The value of this fact also is affected by the possibility of persistence of infection in the cisterns, reservoir, and mains just referred to, and perhaps also by the possibility that

* Early in November a notice was issued by the medical officer of health requesting householders to clean out their water cisterns; and on November 17th the reservoir at Durlston Head was emptied, cleaned and disinfected by the Water Company.

the incubation period of the disease may in these two instances have been somewhat longer than usual. Against the circumstance of the occurrence of cases contracted on or about October 24th and 26th, which is somewhat unfavourable to source No. 4, may be set the continued freedom of the invaded area from infection since October 26th, notwithstanding the fact that No. 4, undiluted by source No. 1, has formed its sole source of supply. While, therefore, review of the foregoing facts and considerations would tend to show that the evidence on the whole points to source No. 1 rather than to source No. 4 as the agency by which the fever was spread, it cannot be said that it entirely exculpates source No. 4. It is indeed possible that both sources were acting as vehicles of infection of enteric fever.

There is, however, another aspect of the matter which bears upon the question as to which source was causing the fever, and, also, if both sources were responsible, on the further question as to which of them was chiefly concerned. I refer to their respective liability to pollution, and especially to specific pollution from the discharges of persons suffering from enteric fever. A detailed account has already been given of the circumstances and surroundings of the well of source No. 4, looked at from the point of view of liability to pollution of the water furnished by it; I now proceed to give similar particulars regarding the well of source No. 1.

Investigation of the surroundings of the well of source No. 1.—As before mentioned, this well is situate at the bottom of the town. It is at the junction of two long streets, having a steep gradient falling towards it, and a short cross street connecting the other two. The two long streets are Park Road and Sentry Road, and the well is entirely surrounded by buildings.

There is no protective area around the well and a house in which enteric fever was notified on October 26th abutted upon the site of the well. On three sides of the well are sewers, two of which, in Sentry and Park Roads respectively, have a very steep gradient. Examination of the sewers in these two roads showed a most unsatisfactory state of affairs. The sewer in Sentry Road passes within 40 feet of the well. There are no manholes on it, but it was opened up in three places above the level of the well and found to be a square rubble drain constructed of pieces of stone laid without mortar or cement. There can be no doubt that a large amount of leakage of sewage must take place from it. A house at which two cases of enteric fever occurred, the date of infection of the earlier of which would have been August 26th, is situate at the top of Sentry Road, and when a mixture of lime and putty was poured down the drain of this house it appeared in the rubble sewer. A similar experiment made with a house lower down the road showed that the house drain was also connected to this rubble sewer, which would appear to have been originally constructed about 40 years ago for surface water only, although now receiving sewage from a number of houses.

The sewer in Park Road passes within 90 feet of the well. This sewer is constructed of glazed socketed pipes, it receives drainage from a large number of houses on both sides of the street, and has a steep fall. There are no manholes or inspection

chambers on it. Examination of it in two places above the level of the well showed that the pipes had given way and had split longitudinally, so that the sewer at these points had collapsed. Three houses in which cases of enteric fever had occurred, the dates of infection of which would have been October 1st, 6th and 21st respectively, are connected to this sewer. Thus this well which constitutes source No. 1, had on each side of it sewers which were leaking and which had received excreta from enteric fever patients. Examination of the well of source No. 1 showed slight but distinct signs of former trickle down the inside of the lining of the well, in the shape of black stains covered with raised confervoid growth. These stains could only have been caused by water passing through the steining from the outside. Below the floor of the well-house also, a few feet from the side of the well, and close to the rising main was a gulley, connected to which was a drain communicating with the defective sewer in Park Road, so that if the drain became blocked or if reflux occurred from it the escaping liquid might obtain entry into the well. There are many possible sources of contamination of the water of this well, but I think the most likely way in which pollution actually occurred was from the broken Park Road sewer in the following way :—

On fourteen days previous to August 23rd there was no measured rainfall at Swanage, and subsequent to August 4th and up to August 23rd on no one day did the rainfall exceed .09 inches. Consequently the clay subsoil of the southern half of the town must have become very dry and must have presented many cracks, as I am informed was actually the case, thus opening up the deeper water-bearing rocks to pollution from surface washings on the occurrence of sudden heavy rainfall. The Park Road sewer has no provision for flushing, and probably, owing to its broken condition, a large amount of solid matter had accumulated during the dry period and had blocked the broken sewer, thus causing liquid sewage to accumulate and to overflow into the surrounding cracks in the subsoil in which it would lodge. On August 23rd the heaviest rainfall of the month occurred, 0.46 inches, and this rainfall, collected from the road surfaces and roofs of houses, probably carried the filth which had escaped from the broken sewer into the fissures of the underlying rock. Thus polluting material was either conveyed directly into a water-bearing fissure, or to the sides of the well, down the outside of which it would then travel till it found a point through which soakage could occur through the stone wall, or until it reached the water level outside the well. The flow of the underground water is well known to be in a direction from south to north and would therefore directly favour such a conveyance of polluting material, which would also be assisted by the action of gravity, the broken portions of the sewer being at a higher level than the well. The date, August 23rd, when this considerable fall of rain occurred has a very close approximation to August 21st, which is the date according to my calculations at which the first case of the outbreak received the infection. In a seaside resort, such as Swanage, it may well have happened that an enteric fever convalescent was, or had been, occupying one of the houses connected to this

sewer; or that there may have been earlier, slight, and therefore undiagnosed, cases of the disease in houses in this road. At the time of my visit liquid sewage was making its way down the Park Road sewer, as shewn on inspection of a manhole at the point of its junction with the short cross sewer in Marshall Row at the bottom of the hill below the well No. 1, so that the obstruction of the sewer was not complete at that date. The rainfall in October, however, was very heavy, having been nearly twice as much as in any previous month of the year, and the effect of this would be to remove any obstruction in the course of the sewer, and also to make the clay subsoil swell up and thus to obliterate all cracks in it and confine the sewage more or less to the line of the broken sewer.

It will thus be seen that the liability to pollution of the water furnished by source No. 1 was very much greater than was the case with the water of source No. 4. All potential sources of contamination are at a much greater distance from the well of source No. 4. There is only one dwelling near it, and there is no history of suspicious illness among the occupants of this dwelling. So far as is known there are no sewers within a quarter of a mile of the well. The well and boring of source No. 4 are very much deeper and of much more recent construction than those of source No. 1. Even if the water of source No. 4 were at all concerned in producing the fever, much the greater share in this is likely to have been due to the water of source No. 1.

I am of opinion that no water which is safe for use can be obtained from a well on the southern side of the town of Swanage. The sources of possible pollution are extremely numerous. In addition to those already mentioned there are a number of private wells near well No. 1 which are disused. As is well known such wells are often on disuse, employed as cesspools, so that filth is carried directly into the water-bearing stratum. This may have been done at Swanage although I have no information to this effect. Owing to the quarrying operations subsidences are liable to occur in many places, and it is quite possible, for instance, that the sewer from the cottage hospital, which receives patients suffering from enteric fever, might at any time become involved by subsidence and allow the sewage to flow into the disused underground workings and thence perhaps into the water bearing stratum. The direction of the flow of water would be such as to convey such matters towards the well No. 1.

Samples of the water from the reservoir at Durlston Head, from source No. 4, which was at that time supplying the area usually supplied from source No. 1, and from source No. 1 itself, were collected by the officers of the urban district council on November 4th, and forwarded for analysis to the Clinical Research Association. The results of chemical and bacteriological examinations of these samples are annexed, in the order mentioned, as an appendix to this report. The results showed, as regards chemical analyses, a close agreement with the analyses already referred to as having been made at the instance of the water company, and as far as their chemical composition was concerned, did not disclose any obvious pollution of any of the waters examined. The results

of bacteriological examination were, however, unsatisfactory ; the bacillus coli, which is held to be derived from the alimentary canal of man or animals, was present in all the samples. In the water of well No. 1, bacillus coli was present in 5 cc. ; in that of well No. 4, at present in use, bacillus coli was present in 10 cc. ; and in the water of the reservoir which had been collecting water from sources Nos. 1 and 4 up to October 22nd, but which on November 4th was receiving water from source No. 4 only, bacillus coli was present in 2 cc.

IV. MEASURES TAKEN BY THE URBAN DISTRICT COUNCIL FOR PREVENTING THE SPREAD OF ENTERIC FEVER.

There is no hospital provided by the urban district council for cases of enteric fever. A villa residence which they rent to serve the purpose of an isolation hospital has been employed for isolation of cases of scarlet fever only, of which disease there have been 33 cases during the present year. This house is not surrounded by an unclimbable fence and in other respects does not comply with the Board's requirements for a hospital intended for cases of infectious disease. Enteric fever cases have been accommodated in the cottage hospital and in a nursing home at Swanage. In all, 13 patients have been removed from their homes to these institutions. There is no disinfecting apparatus ; and no ambulance for removal of cases of infectious disease. Where cases of enteric fever have been removed from their homes within a few days of notification, the bedding has not been disinfected separately, but the room occupied by the patient with the contained bedding has been fumigated with the vapour of formaline. Bed clothes and clothing have been steeped in a solution of carbolic acid, and soiled bedding has been destroyed. Drains and water closets have been disinfected with liquid carbolic acid supplied by the district council.

Soon after the outbreak of enteric fever was declared many people in Swanage began to boil all water used for domestic purposes as also milk. This has been particularly the case in the private schools of which there are a considerable number, and has been done on the advice of the medical practitioners of the town. At the convalescent institutions, the hotels and boarding houses, as well as at many of the large private houses, the same precautions have been adopted and are being continued.

For assistance in my investigation I am indebted to the officers of the urban district council, to members of the council, to officers of the gas and water company who have given me every information in their power, and to the resident medical men of the town, as well as to many in distant places who have given me information about visitors attacked by fever after leaving Swanage.

S. W. WHEATON.

APPENDIX.

The Clinical Research Association, Limited,
Watergate House,
Adelphi, London, W.C.
14th November, 1910.

No. 6688/11.

TO DR. A. McCAUSLAND.

The Specimen of Water marked No. 1 from a covered reservoir* received here on 5th November, 1910, has been examined and I have been instructed to forward the following Report thereon :—

RESULTS.

—				Grains per Gallon.	—	Parts per 100,000.
(1.) <i>Chemical</i> —						
Total Solids (dried at 120° C.) ...				56.77		81.10
Combined Chlorine				6.70		9.57
Expressed as NaCl				11.05		15.79
Nitrogen as Nitrates				0.01		0.01
Nitrites				Nil.		Nil.
Saline Ammonia				0.0019		0.0027
Albuminoid Ammonia				0.0028		0.0040
Oxygen absorbed in 4 hours at 27° C. ...				0.016		0.023
Temporary Hardness					21°·2	
Total Hardness					35°·4	
Permanent Hardness					14°·2	
Lead or Copper				Nil.		Nil.
(2.) <i>Bacteriological</i> —						
B. Coli					Present in 2 c.c.	
Strepto-cocci					Present in 10 c.c.	
B. Enteritidis Sporogenes					Not found in 100 c.c.	

CONCLUSIONS.

These results show the water to be decidedly hard and polluted with sewage or animal excreta to a dangerous extent.

We have been unable to isolate the Typhoid Bacillus, but the practical difficulties in the detection of this organism in water are so great that a negative result cannot be regarded as any real evidence that it is not in fact present.

C. H. WELLS,
Secretary of the Association.

* At this time the water in the reservoir was from source No. 4 only.

The Clinical Research Association, Limited,
Watergate House,
Adelphi, London, W.C.

14th November, 1910.

No. 6689/11.

To DR. A. McCAUSLAND.

The Specimen of Water marked No. 2 from a well, source No. 4, 400 feet deep received here on 5th November, 1910, has been examined and I have been instructed to forward the following Report thereon :—

RESULTS.

—				Grains per Gallon.	—	Parts per 100,000.
(1.) <i>Chemical</i> —						
Total Solids (dried at 120° C.)	...	...	...	59.64		85.20
Combined Chlorine	...	...	...	7.10		10.14
Expressed as NaCl	...	...	...	11.71		16.73
Nitrogen as Nitrates	...	...	...	0.01		0.01
Nitrites	...	...	...	Nil.		Nil.
Saline Ammonia	...	...	...	0.0037		0.0053
Albuminoid Ammonia	...	...	...	0.0024		0.0034
Oxygen absorbed in 4 hours at 27° C.				0.015		0.021
Temporary Hardness	...	...	...		21°·7	
Total Hardness	...	...	...		36°·8	
Permanent Hardness	...	...	...		15°·1	
Lead or Copper	...	...	...	Nil.		Nil.
(2.) <i>Bacteriological</i> —						
B. Coli	...	...	...		Present in 10 c.c.	
Strepto-cocci	...	...	...		Present in 10 c.c.	
B. Enteritidis Sporogenes	...	...	...		Not found in 100 c.c.	

CONCLUSIONS.

These results show the water to be polluted with sewage or animal excreta. In its present condition it cannot be regarded as safe for use for drinking, and it is decidedly hard.

We have been unable to isolate the Typhoid Bacillus.

C. H. WELLS,
Secretary of the Association.

The Clinical Research Association, Limited,
Watergate House,
Adelphi, London, W.C.

14th November, 1910.

No. 6690/11.

TO DR. A. McCausland.

The Specimen of Water marked No. 3 from a well, source No. 1, 130 feet deep received here on 5th November, 1910, has been examined and I have been instructed to forward the following Report thereon :—

RESULTS.

—				Grains per Gallon.	—	Parts per 100,000.
(1.) <i>Chemical</i> —						
Total Solids (dried at 120° C.)	...	...	...	45.92		65.60
Combined Chlorine	...	...	...	3.70		5.29
Expressed as NaCl	...	...	...	6.10		8.71
Nitrogen as Nitrates	...	...	...	0.24		0.34
Nitrites	...	...	...	Nil.		Nil.
Saline Ammonia	...	...	...	Nil.		Nil.
Albuminoid Ammonia	...	...	...	0.0030		0.0043
Oxygen absorbed in 4 hours at 27° C.				0.016		0.023
Temporary Hardness	...	...	...		15°-9	
Total Hardness	...	...	...		31°-1	
Permanent Hardness	...	...	...		15°-2	
Lead or Copper	...	...	...	Nil.		Nil.
(2.) <i>Bacteriological</i> —						
B. Coli	...	...	...		Present in 5 c.c.	
Strepto-cocci	...	...	...		Present in 10 c.c.	
B. Enteritidis Sporogenes	...	...	...		Not found in 100 c.c.	

CONCLUSIONS.

In its present condition this water cannot be regarded as safe for use for drinking purposes, the above results indicating recent pollution with sewage or animal excreta, and it is decidedly hard.

We have been unable to isolate the Typhoid Bacillus.

C. H. WELLS,
Secretary of the Association.



