the fresh-air life whenever possible. Borrow, like his other gypsy literary friends, was a true 'Child of the open-air,' and this phrase perhaps best defines the gypsy spirit and the gypsy breed. He used to make a mighty figure as he strode across Wimbledon Common between the whin bushes or through the quags, stopping occasionally to pick from the pools the wild mint, or watch the water wagtails by the ponds. There still remains the memory of Borrow as a silvery-haired giant of eighty, lingering for hours under the noble trees of Richmond Park; anon looking around him with nature-hungering eyes, as he murmured in a dreamy way, 'Old England! Old England!'

As has likewise sighed many another 'child of the open-air,' whether a dweller in gypsy van under the stars, or cramped by walls of brick and mortar within the town.

EDWARD PAGE GASTON.

AN HISTORICAL SKETCH OF THE WATER SUPPLY OF THE DISTRICT

THERE are few chapters in history that throw more light on the state of civilization that existed amongst our predecessors than that which records the means they took to provide their communities with water. Remains still record the magnitude of the works undertaken, and many of the ways in which water was used, such as baths, fountains, the removal of sewage, etc.

The necessity for bringing water to London was not felt to the same extent as in many cities from the fact that most of the area comprised within the city walls, and that on which extensions took place, was situated on the gravel beds that overlaid the London clay, in which beds water was found within a few feet of the surface. It would also appear that subsequent to the Roman occupation of Britain water was not used to the same extent until comparatively recent years.

In the reign of James I water was first brought to London by open channel and distributed in wooden mains. Prior, to this date, however, Cardinal Wolsey, in 1515, took water from Coombe, within a mile of the western boundary of Wimbledon, for the supply of drinking water to Hampton Court Palace. This supply was continued until the year 1876. The feeding drains, mains, and conduit chambers are shown on the six inch and twenty-five inch ordnance maps. The main, which is in duplicate, crossed the site of the Kingston Union, the Fairfield, the Thames above Kingston Bridge, and entered the Home Park. A photograph of one of these conduit chambers is reproduced in figure 1, and in figure 2 a piece of the lead pipe which was laid side by side to form the main. This pipe weighed 15lbs. per lineal foot, had a sectional area of 3·8 square inches, and was of a form which resembled that now given to sewers and water conduits known as the 'egg-shape.' The reason for the adoption of the egg-shape form of conduit, especially in the case of sewers, is that when the depth of liquid in the sewer does not exceed one-third the total depth, the surface of the sewer exposed to the flowing liquid is much smaller than it would be in the case of a round or circular sewer, and therefore

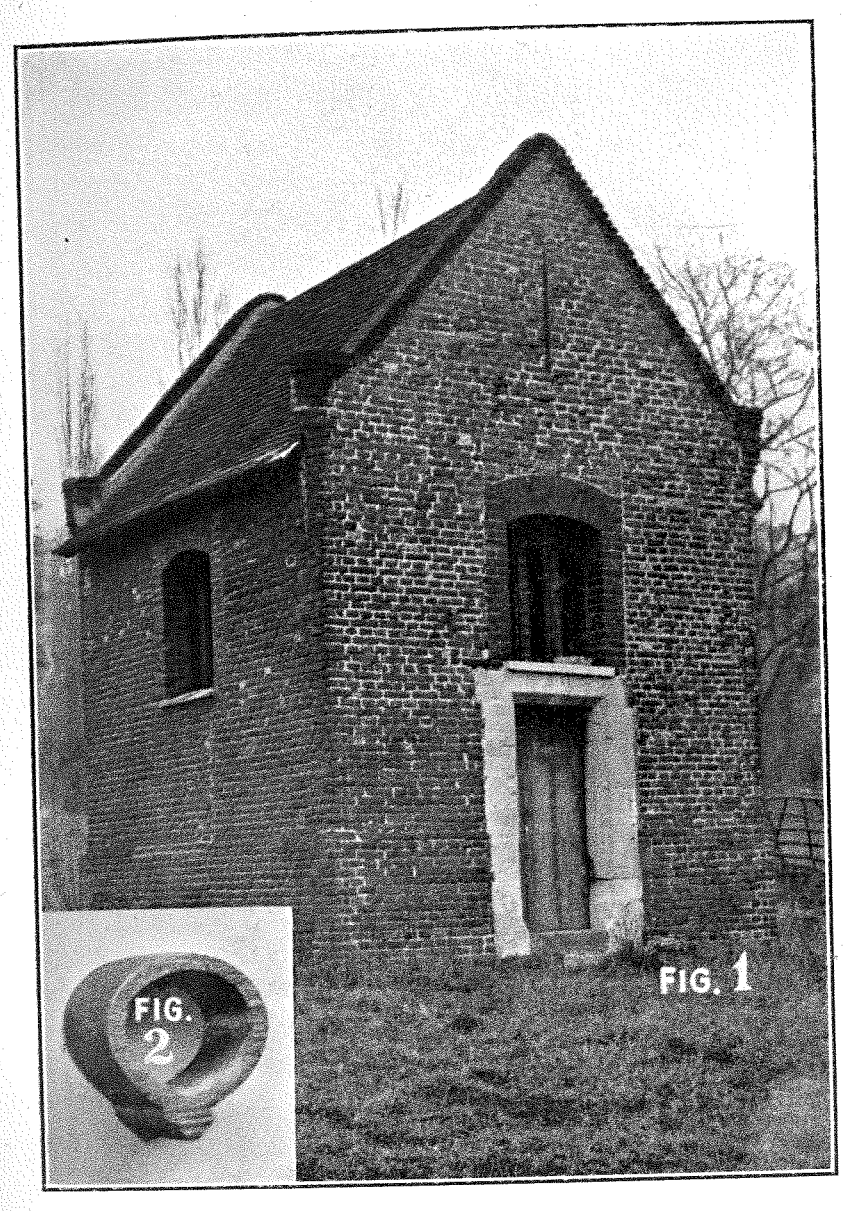
offers less resistance to the flow. That this section should have been adopted in water mains laid at so early a date is evidence of a knowledge of hydraulics that one would not have expected at that time, and the duplication of the system shows that the designer, so to speak, was far in advance of his time. Forty tons of these mains were removed some few years since from Coombe and Norbiton, and it is to be regretted that specimens were not preserved in the local museums. The writer is indebted to Mr. E. Chart, architect at Hampton Court Palace, and to Messrs. Cluttons, of Whitehall, for the information concerning this ancient supply.

As the early developments of London were confined to the area of the gravel beds, so in the case of Wimbledon and Merton, the older houses, such as are met with in West Place, Crooked Billet, Wimbledon Village, Merton Rush, Kingston Road and the Double Gates, were situated on gravel beds.

About the year 1850 the Lambeth Water Works laid mains through the district for the supply of water from Thames Ditton to this district and to London, this being the first attempt to take water from the Thames above Battersea for the supply of the Metropolis. These mains entered Merton on the north

side of the London and South-Western Railway, between New Malden and Raynes Park Stations. The line they took may be clearly seen by the cuttings and embankments which were made to allow of the mains being laid at the required falls. That it was considered necessary to incur such expense at so recent a date reflects on the knowledge of hydraulics at that date. The effect of this comparatively pure supply was clearly demonstrated in the cholera outbreak of 1854, when the deaths amongst the consumers reached only four per 1,000, whereas the deaths amongst those supplied by the Southwark and Vauxhall Water Company were thirteen per 1,000 (see sixth report of River Pollution Commission, page 143).

Subsequent to the laying of this main those portions of Wimbledon and Merton much built on were supplied by the Lambeth Company, except the higher part of Wimbledon, *i.e.*, the portion above what is known as 'the 100 contour.' As the Lambeth Company had not at the time sufficient pressure to supply the remainder of Wimbledon, the Southwark and Vauxhall Water Company did so at a later date. As this Company, however, had no statutory power, the Local Board in the year 1876 instructed the late Mr. S. C. Homersham,



CONDUIT CHAMBER, GALLOWS HILL, COOMBE, AND SECTION OF LEAD WATER PIPE, IN CONNECTION WITH CARDINAL WOLSEY'S WATER SUPPLY TO HAMPTON COURT PALACE. 1515

M.I.C.E., a well-known hydraulic engineer, to prepare a scheme for the supply of Wimbledon. Mr. Homersham selected the chalk as his means of supply, and placed the site of his well near the Woodmansterne boundary, south-east of Oak's Park. Wimbledon in 1876 had not 12,000 inhabitants, yet Mr. Homersham at that time estimated that in ten years the population would be 19,000, a figure it closely corresponded to, and that in twenty years it would be 31,000, at which date the actual population was between 32,000 and 33,000. In 1883 the Board instructed their then Engineer and Surveyor, the late Mr. W. Santo Crimp, M.I.C.E., F.G.S., to prepare a scheme for the supply of the higher portion of the district, on the preparation of which the author was engaged. It was then proposed to take water from the chalk near the junction of Smitham bottom and Chipstead bottom, Woodmansterne. Unfortunately the Board were not inclined to undertake either of these schemes, and in lieu thereof the Southwark and Vauxhall Water Company was allowed to obtain its Act of 1884.

The supply furnished to the district by the Lambeth and Southwark and Vauxhall Water Companies was derived exclusively from the Thames, a water which has never been

of a high quality, as will be seen by comparing the analyses given by the Registrar-General's weekly returns from which the following table has been taken, to which the analyses of the Kent Water Company's supply is added in order to show the superiority of water derived from wells sunk in the chalk.

LONDON WATER.

Mean of analyses of samples taken in December, 1902, in January, February and March, 1903, in parts per 100,000.

Company supplying.	Oxygen absorbed in 4 hours at 80 deg. F.	Organic Nitrogen found.	Albuminoid Ammonia.	Remarks.
Kent... ...	·006	·005	·0015	Supply from wells
Southwark	·115	·023	·010	Supply from the Thames
Lambeth ...	·138¼	·032½	·011¾	do.

It is only fair to the Water Board to state that they have, since coming into power, done what they could to obviate the cause for complaints made as regards the quality of the supply by furnishing water from their well at Streatham, and the writer understands that it is the intention of the Board to give the district the full benefit of the water that will be derived

from the Merton Abbey well, which will be alluded to later.

ARTESIAN WELLS.

The object with which this paper was invited was not so much to describe what the Water Companies have done, as to place on record the information the author has as regards the supply furnished by artesian wells to houses within the district. Prior to the year 1880 there were in Wimbledon twenty-six wells, with 260 houses supplied therefrom, and six wells with sixty houses supplied therefrom in Merton, giving a total of thirty-two wells and 320 houses, whilst in the surrounding districts of Mitcham, Tooting, and Wandsworth, a very large proportion of the population was supplied with water in a similar way. In order to get some idea of the source from which this water is derived, and from where the pressure is obtained which causes the water to rise above the surface, it is necessary to refer to what is geologically known as the 'London Basin,' formed by a series of strata which in form resemble a number of basins resting one inside the other. First comes the chalk marl, which is impervious, and forms the bottom or lower basin of this series of strata, and which comes to the surface at Merstham, whence it dips beneath London at

a depth of about 900 feet, coming again to the surface north of the Metropolis, as shown in figure 3, which represents a section from south to north of the London Basin. Overlying the impervious basin formed by the chalk marl we have the water bearing strata of the chalk and Thanet sands, which come to the surface on the south at Croydon, Beddington, Carshalton, Sutton, Epsom, etc., and extend to Merstham, Gatton, Betchworth, Dorking, etc. These strata form in a similar manner a basin dipping beneath the Metropolis, and having a thickness varying from 400 to 1,000 feet. Over these water bearing strata we have those alternating beds of sand and clay in variegated colours which can be so clearly seen in Alum Bay, Isle of Wight, known as the Woolwich and Reading beds, which, together with the London clay, form an impervious basin immediately overlying the Thanet sands and chalk, which prevents the water contained in the sands and chalk from rising, in other words keeping the sands and chalk constantly charged with water. The outlet for this water, by nature provided, is over the edge of the impervious basin, which may be seen in the form of springs where such edge is depressed, as at Croydon, Beddington, Carshalton and Ewell in this

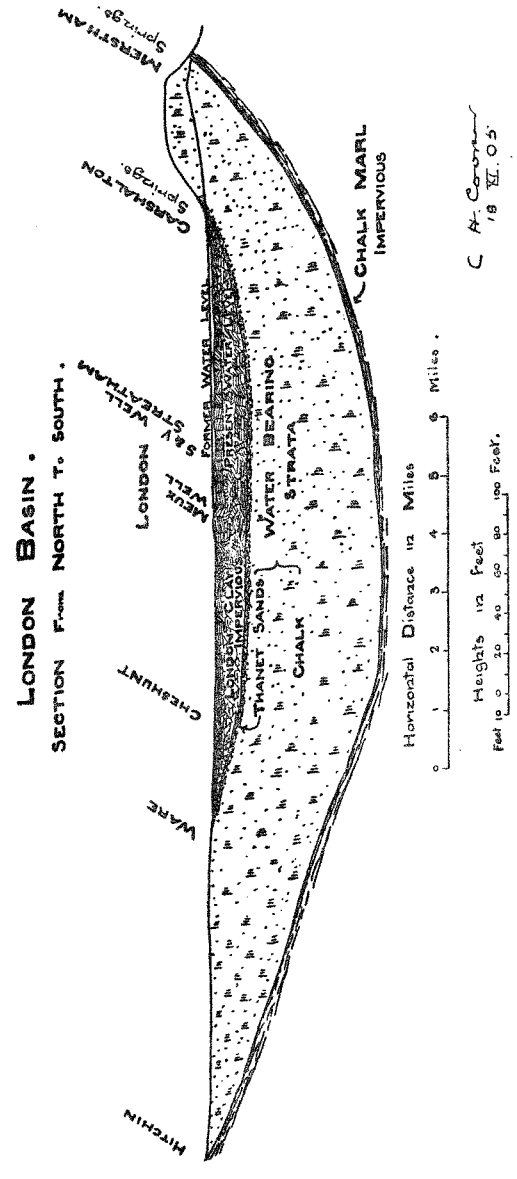


FIG. 3.

neighbourhood. The first three springs form the Wandle heads, whilst the last gives rise to the Hoggs Mill Brook. Many similar springs are to be seen round London.

By piercing through the impervious strata overlying to the water bearing strata of the Thanet sands and chalk, the water thereby liberated rises approximately to the level of the nearest spring. In the cross section of the London Basin given in figure 3, the writer shows, in a full line, the height to which the water formerly rose. Unfortunately the height is now reduced to the level shown by a dotted line on the same diagram, due to the quantity of water abstracted by subsequent borings.

Amongst the first borings sunk into the London Basin was that at Wimbledon Park House in 1798, a description of which is given in Bartlett's 'History of Wimbledon', pages 182 and 183, which, so far as the description of the strata passed through is concerned, is misleading; this well was sunk by hand in an open shaft. The building erected over this well still exists in the grounds of Well House, Arthur Road, close to the public footpath.

In the year 1822 the first tube well in the district was sunk at Tooting Church, the water rising to a level of seven feet above

the ground, and yielding 130 gallons per minute. The success of this well was so great that wells continued to be sunk in the immediate neighbourhood, so that in the year 1876 Mr. Joseph Lucas, F.G.S., estimated the number in the Wandle Valley at 110. These wells continued to increase in number until the year 1887 when, owing to the water abstracted by the Southwark and Vauxhall Water Company in its pumping operations at Streatham, a large number were affected. Since pumping has been in operation at the well sunk by this Company at Merton Abbey the wells have failed, except those from which water is pumped, thus the water line which rose to the surface in the well at the Sewage Farm, Durnsford Road, now stands at a depth of thirty feet below the surface. The only wells in Wimbledon from which supplies are now derived are those at the Atkinson Morley Hospital, Copse Hill, and at the Sanitary Laundry, Cranbrook Road; in both cases the water is raised by pumping.

It may naturally be asked how it was that the possessors of these wells allowed the supply furnished to 320 houses in this district to be abstracted, as has been done by the Water Companies, without any compensation being obtained. Unfortunately there is a prin-

ciple in law as regards easements which may be acquired by an owner. Thus an owner is supposed to possess whatever his freehold subtends from the centre of the earth beneath to the heavens above and he can acquire an easement for all water, light and air, coming to such freehold provided the same comes by well-defined channels as water does when it comes by a river or watercourse, or as light and air do through a window. Unfortunately underground water comes in no such defined channel—therefore no easement or right for same can be acquired.

The writer well remembers the district since 1878 when many wells overflowed and subsequent to which date many wells were sunk. Amongst the principal wells may be mentioned that at Paxton's Patent Leather Works, Wandle Villa, where water rose to a considerable height above the surface and worked an overhead water-wheel that produced the power necessary to operate a mill for grinding the ingredients used in the process of manufacture. There were several wells overflowing on the sides of highways which supplied a large number of houses in the district—for instance: (1) one in Summerstown just outside the Wimbledon boundary, which furnished a supply for sixty houses; (2) another in High

Street, Merton, on the north side of Haydon's Road, just opposite the site of Lord Nelson's stables, which supplied some twenty-five houses. The overflow from the well which supplied 'Spring House,' Merton Park, formerly occupied by John Strange Winter, flowed into a basin from which a number of houses in the immediate neighbourhood derived their supply. In 1885 Mr. C. Bewsey had a well sunk on the south side of Granville Road for the supply of seventy-eight of his cottages. The well-sinker before undertaking the contract, which provided for a certain supply at such a height that it would command the cisterns in the cottages, took careful observation of the nearest well situate within 500 feet which supplied a well-known tavern and in addition caused the fountain in the grounds of the tavern to play night and day. Although the well-sinker continued his borings beyond what he had anticipated the water did not rise above the surface. He had therefore to furnish an engine and pump in order to allow Mr. Bewsey to raise the water to the height required by his contract. It was not until some years after that, in making alterations it was found that the tavern well had been connected with the water mains of the Lambeth Water Company.

About the year 1874 the British Land Company which had laid out the roads on the south side of the Broadway and Merton Road, between Wimbledon Station and Southey Road, were compelled by the Courts to abandon a connection they had made with the sewers of the 'Church of England' Estate. This placed them in a dilemma as regards how to dispose of the sewage in question, when their advisors were inspired with an idea, the carrying out of which, so far as the writer is aware, had never before been attempted, and it is to be trusted will never again be resorted to, viz. :—that of raising the sewage by means of a windmill to such a height as to allow of it gravitating through a disused artesian well, and so polluting a water supply that had hitherto been free from all contamination. This was done in a well near the end of Graham Road close to Merton Park.

In cases where several cottages belonged to one owner such owner had his own private water supply derived from an artesian well which filled a cistern at a sufficient height to command the cisterns in the several cottages. This was done in Deburgh, Hubert, South and North Roads, and a number of other cottages. The water supply from these wells was that which had fallen on the out-

crop of the chalk in the form of rain at a remote period and in consequence was free from organic matter likely to contaminate it. It was a soft water having a constant temperature of 52° F., which was a supply that would have been most useful especially in a district with such a large number of laundries as at present exist.

In several of the old houses in South Wimbledon and Merton the basins of the fountains which formerly played night and day with water supplied by these wells are still to be seen. Owing to the temperature at which the water flowed from these basins, they formed a shelter in which frogs found a comfortable home during the winter months and in which several water plants flowered.

The last artesian well sunk in the district was in 1893 at the watercress beds in Plough Lane, the depth being 166 feet. The water rose to about forty-seven feet above ordnance datum, and the yield from the well was 2,600 gallons per hour. This well, however, had a very short life as, in common with the wells at Summerstown, the Willows and Copper Mill Lane close by, it failed in 1896. The lowering of the water level which caused these wells to fail was due not only to pumping operations by the Southwark and Vauxhall Water Company

at Streatham, but also to the pumping in connection with the well sunk by this Company east of Merton Abbey Station. This well, which is sunk where the chalk comes to within 225 feet of the surface, is situated in the area that has yielded the best wells in the neighbourhood. The total depth is about 300 feet, the bore being of considerable diameter (10 feet), which allowed of adits being carried from the bore so as to tap the flow of water underground as much as possible. When the permanent pumps are erected at this well the writer has no doubt but that in time the effect on the springs supplying the Wandle will be considerable. Should the amount of water abstracted from the chalk in the neighbourhood increase as it has done of late years, the writer expects to see those springs cease which now so enhance the scenery of Beddington and Carshalton, and, by the uniform temperature of the water they emit, tend to equalize the climate throughout the year in their immediate vicinity.

Further information regarding wells may be obtained by reference to a paper by Mr. Joseph Lucas, Proceedings of the Institution of Civil Engineers, Volume XLVII, and the paper already alluded to by Mr. Lucas read before the Society of Arts (see their Journal for May 11, 1877).

Well-sinkers and engineers owe a deep debt to Mr. W. Whitaker (past President of the Royal Geological Society) for the records of wells sunk which he has from time to time published, at his own expense, as the Geological Survey Office would not take up this useful work.

The author has not referred to one of the most interesting phenomena to be observed in respect of the water flowing from the chalk, viz. :—that of the bourne, a well-known example of which occurs in the Caterham Valley. This bourne last overflowed between November 23, 1903, and May 20, 1904, being the longest period of flow on record, due to the exceptionally heavy rainfall of 1903. The previous flow took place in 1897.

A most interesting paper on the flow of this bourne was read by Mr. Baldwin Latham before the Croydon Natural History and Scientific Society on May 17, 1904. A paper coming from one who has devoted so many years to careful records as regards the water supply of the chalk cannot fail to be of deep interest, and the author, before concluding, would like to place on record the sincere debt of gratitude he owes to one who assisted Mr. Latham in his observations for many years and with whom he had the pleasure of subsequently

working as assistant for ten years, namely—the late Mr. W. Santo Crimp, whose early demise was deplored by a large circle of engineering friends.

C. H. Cooper.

OCTOBER 21, 1905.*

From sunrise unto sunset
  The laden ships go forth ;
They bear the fabrics southward,
  They bear the spices north :
They hear the young blood chafing
  The wider lands to roam,
They hear the tired hearts sighing,
  And bring the old men home.

They know the East Wind's hiding,
  They know the West Wind's path!
They scorn the low reef's thunder,
  They dare the deep sea's wrath.
The breath of God may smite them,
  The fires of God may slay,
But no man's hand shall plunder,
  And no man's hand shall stay.

They render none the tribute ;
  They tread the ancient sea
As princes by their birthright,
  Imperial, proud and free.

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