

SECTION III.  
CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS,  
BY W. WHITAKER, B.A., F.R.S., F.G.S., ASSOC. INST. C.E.,  
ASSOC. SOC. MED. OFFICERS OF HEALTH.

PRESIDENT OF THE SECTION.

---

*Tria Juncta in Uno.*

THE President of this Section is placed in some difficulty, as he has to represent three sciences, and to pose as a living representative of a Trinity in Unity. If in trying to fill such a post I should stop far short of success, let not the failure be credited to the defects of an ordinary mortal, in no way answerable for an arrangement assigning to him an apparently impossible task. A three-legged stool is undoubtedly the most unstable of seats, and therefore if I slip, it is the fault of the chair that I have to take.

It is true that, with an eye to human fallibility, the Council select a President from the votaries of one of the three sciences in succession, leaving him to speak on his own science and to more or less ignore the other two; but I have thought that it might be well to choose a subject in some way common to all three for the discursive remarks which are all that I can offer. After much searching of heart, strange as it may seem, the only common ground that occurs to me is *water*: indeed that subject might also include a great part of the other two Sections into which our Congress is divided.

In the first place as to the meteorologists. It is clear that we owe all our water directly to them, and that they are not answerable for the many objectionable materials that so often get into the water, not even for the salt, of which we sometimes have unpleasant experience in supplies along the coast.

In the past twelve months there has been a respectable rainfall, resulting (amongst other things) in the replenishment of

our stores of water, and to such an extent underground as to bring on the formation of the bournes, the outbreak of springs in places where the water-level, in permeable rocks, is usually at some depth underground, causing thereby the flow of streams in valleys, or parts of valleys, that are usually dry.

This has occurred in the two well-known examples north and south of London, in Hertfordshire, and in Surrey. Water broke out in the Kenley Valley (part of the watershed of the Wandle) at successively higher points and flowed over the surface to successively lower points, until the stream reached from the junction of the two valleys north of Marden Lodge to the Brighton Road northward of Purley Station, a course of about four miles.

Some weeks later the Hertfordshire bourne rose, in a tributary valley joining the valley of the Bulbourne at the place called Bourn End, a mile and a quarter above Boxmoor Station. The springs rose higher and higher up the valley until the stream started, at the boundary between Hertfordshire and Buckinghamshire, in the bottom of the valley southward of Harrats End and about two and half miles above Bourn End, at which latter place it joined the River Bulbourne.

I saw both these bournes, the former repeatedly, and it was very interesting to see the unusual stream, with occasional broadenings-out into fair-sized ponds, flowing over grass-land and through gardens, here and there making incursions into stables, sheds, cucumber-frames, &c. In the Hertfordshire case a goodly length of roadway, at the lower part, was turned into a stream.

At first sight it may seem strange that the outburst in the two tracts should not have occurred at about the same time, both being of the same geologic formation, the Chalk. The explanation of the difference in time of starting seems to be that in the southern tract the outcrop of the Chalk is narrower, the dip of the beds and the slope of the ground at higher angles (though far from high); from which it follows that the water would find its way more quickly from higher to lower levels underground than in the northern tract, where the broader outcrop, due to lower dip and accompanied by lower general slope, tends to delay the underground flow. I venture to give this explanation, until a better one is offered.

There is no need to say more of these bournes, the occurrences having been carefully recorded in both cases, as they have been in earlier outbursts. Indeed, I have an idea that the Surrey bourne is sometimes thought to be in the hands of our Fellow, Mr. Baldwin Latham. At all events he names the day when an outburst may be expected, and his orders are

punctually attended to. These streams are, of course, only two of a great number of such occurrences; but I fear that others are not so well recorded, at least we do not hear that they are.

On 12th March, 1897, I saw a like thing, on a smaller scale, in the Magnesian Limestone tract near Mansfield, where the floors of stone-quarries, at Mansfield Woodhouse Station and westward, were under water, and there was a flow for a short way along the Valley of Debdale Lane, in two places, one southward of Debdale Hall, the water sinking again after a time, and the other from east of the Hall.

Of bournes generally one may remark that, whilst years ago there were various wonderful theories accounting for the occasional outflow of water, the progress of science has simplified matters, and we now know that these outbursts are merely owing to rise of the underground water-level, after seasons of heavy rainfall, until it becomes an overground one along the bottoms of valleys.

There is one other satisfactory matter on which meteorologists and The Sanitary Institute generally can be heartily congratulated, workers in all sciences joining in the voice of congratulation: it is the award of the Albert Medal by the Society of Arts to one who may well be called our good Fellow, Mr. G. J. Symons. In his particular domain it would need some hardihood to venture on anything approaching to fault-finding: but I would humbly suggest that sometimes we should not be averse to more information from the higher grounds. These are naturally the parts where the greatest rainfall is to be expected, and they are of special importance in regard to water-supply. Of course, they are those about which it is generally most difficult to get information. In parts of the low grounds the amount of rainfall is practically immaterial in reference to the subject of water-supply, from which point of view it matters little, for instance, whether there is a fall of 10 inches or of 100 inches a year in such places as London, Liverpool, and Manchester (or even in Leeds), though from other points of view there may be something in it.

The important science of chemistry has been duly recognised in the Jubilee honours, and all of us must have been glad to have found the already well-honoured names of Frankland and of Crookes in the list. With regard to the former, the Order of the Bath seems to be a most appropriate award for one who has done so much for water.

I take the opportunity now offered to ask to be allowed to utter a protest, not against the matter with which chemists provide us, but rather against the manner in which they often

present it to us. In doing this of course I have no notion of arrogating to myself a superiority over my chemical brethren: I only ask that they should consider the feelings of those who, though not themselves chemists, have often to study chemical analyses. It would be a great advantage to us if they would agree to use one system in stating their results, instead of several. Now-a-days, when one gets a chemical analysis, one has to see in what language it is written, whether, for instance, the results are given in grains per gallon, or in parts per hundred thousand, with an occasional limit of deviation to a million. We may be told that we have only to multiply by  $\cdot 7$  to change one set of figures into the other; but I venture to submit that life was not given us for the purpose of carrying on the process of multiplying by  $\cdot 7$ , and that some of us might be better employed than in following that occupation. In common with most people, I like to have my food cooked for me. I can then give my undivided attention to digesting it.

Another common defect in water-analyses is not due to the chemists, but rather to their clients: it is the imperfection of most analyses. Folk seem to think that it is generally enough to know whether or not there is any organic pollution in a water; but I do not hesitate to say that it is sometimes as important to know the mineral contents. When these are known the geologist is not left wholly to his own devices, which are very various, in trying to trace out the history of a water, but is greatly helped by the chemist. Full analyses of water are of great value, and clearly we want more chemistry.

The following complaint is hardly one that should be limited to chemists; but they are frequent offenders, and what I venture to call a wrong practice may be noted here, namely, the addition of needless noughts after decimals. No one can deny that "a tenth" is a better expression than "ten hundredths," far better than "a hundred thousandths," and immeasurably above "a hundred thousand millionths." Yet they all mean the same thing! When put in figures many folk prefer anything to the first,  $\cdot 1$  won't do for them; but they must put a long array of 000 after the 1. This may be impressive, but surely figures are among those blessings of which one may have too much.

Coming now to more general questions in regard to water-supply I must ask forgiveness if my erratic remarks stray across our boundary into the domains of other sciences or pursuits.

In the course of the past Session of Parliament two Bills, promoted by the Corporations of Nottingham and of Newark, had a somewhat lengthened consideration in a Committee of the

House of Commons. Luckily they were taken together, or the nineteen days given to them might have been extended to thirty.

This enquiry, during part of which I was present, had some peculiar features. In the first place there was not a single Company in the case; but there was a multitude of corporations and of other local authorities, opposing the whole or part of both Bills, and one was tempted to say, "How these Councils love one another!" A second peculiarity, and one which this Section must feel to be a very bad one, was the absence of chemists, an occurrence previously unknown I believe in such a case! The fact is that no question of quality arose. Everyone knew that there was good water to be got, the only things to settle were, firstly, who was to have it, and then where they were to get it. In both cases the New Red Sandstone was the source of supply involved, and by means of wells.

But, besides these trifling peculiarities, a point came up in both bills, one, I think, of great importance, and likely perhaps to lead to results toward which engineers and others have been striving for some time. It may also lead to results of a specially sanitary kind, and it is in the hope that this may be the case that these bills are now referred to.

In each case the promoting corporation asked for what was called, I believe, a protective radius; really a ring within which no other works for public supply should be established, their own works being, of course, the centre of the circle. A protected area would clearly be a better term, as no good could be got from an abstract idea like a radius.

One of the two schemes was for the supply of a population of 20,000, whilst the other was for a population nearly 15 times as large. With the usual perversity of human nature, the promoters of the smaller scheme asked for the larger radius (four miles), and to have it for nothing: the result being that finally the application was unsuccessful, whilst the promoters of the larger scheme asked for a smaller radius (two miles) and got it, by paying for it.

It seems not unlikely that this question of a protected area round a waterworks will occur again, and frequently. Clearly there is some justice in the notion that a public authority or a company spending money on getting a good supply of water should have some direct guarantee that its efforts should not be frustrated by other work being undertaken too close to it. Naturally there will be difficulties in making such arrangements, but I cannot see why our engineering brethren should not be able to surmount them, if, with their usual modesty, they do not open their mouths too wide.

Of course, each case must be decided on its own merits. No hard and fast rule should be striven for, as what may be ample in one case may be far from it in another. Nor, perhaps, should there be the geometric simplicity of a circular area in all cases.

I have clearly been trespassing in the domain of the Engineering Section; but this trespass may be forgiven as it has been done for a good object, the finding of a text for a very short sanitary sermon. Service on a Government Survey has made me so used to going over other people's property, for many years, that I am loth to give up the practice, though no longer an officer of that Survey.

This question of a protected area round waterworks seems to me to be one that should be extended beyond the original purpose, and from a sanitary point of view. Whilst recognising the importance of getting water free from interruption, let us not forget the at least equally important matter of keeping the water free from pollution.

There are some people who would not allow the establishment of any sewage-farm, or perhaps of any cemetery, on a water-bearing formation; but this seems too much to ask for, as there may be places on such formations where, as far as one can see, no harm can result from such proceedings, and we must remember that sewage-farms and cemeteries must exist, until some other methods of disposing of waste material are not only found out, but are generally adopted: moreover, such institutions cannot always be far removed from populous places.

Surely, however, it is not unreasonable to suggest that round each work for the public supply of water a certain tract of the water-bearing bed should be saved from the assaults of surface-contamination. We are yet without much information as to how far pollution may be able to reach along an underground course, and there is still great dispute as to its extent along an overground one. Clearly here, too, each case would need careful consideration, both as regards the position and character of the waterworks, and the nature and amount of the possible polluting-cause, lest work should be stopped at places where it would do no harm, or allowed at places where harm is likely to ensue.

It has been legally settled, by the case of *Ballard v. Tomlinson* (which I had the pleasure of bringing under the notice of *The Sanitary Institute* in 1885), that no man has a right to pollute the water in another man's well, where communication between the work of the polluter and the well of the polluted can be proved. But this does not go far enough for sanitary purposes. We want to stop the pollution before it is proved.

The sanitary requirement is that no pollution shall be allowed on a water-bearing bed where such pollution is likely to affect a neighbouring waterworks or well. I do not see that at present we can go beyond the bounds of probability; but that is a wide range, quite enough to stop many doubtful practices. Whether we shall ever be able to go to the extent of possibility is another question.

It is here that geology comes in, for the nature of the surroundings of waterworks must be taken into account, often for some distance and to some depth.

The character of the beds at the surface is of course very important and an ordinary geologic map, on which the Drift (gravel, loam, boulder clay, &c.) is not shown may sometimes be misleading in this respect. As sanitarians we should rejoice therefore at the revision of the Geological Survey Map which has now been going on for several years, and, including the mapping of the Drift, a revision that really amounts to a new work rather than merely to a new edition.

In southern England the Drift has been mapped and published on many sheets of the old map, including the whole of the counties of Essex, Middlesex, Norfolk and Suffolk, with a great part of Cambridgeshire, Hertfordshire, Kent, and Surrey, and with a smaller part of many other counties. This work has also extended further northward, into some of the Midland Counties (though very little has yet been published); but in by far the greater part of the wide tract referred to it has been done only on the old one-inch Ordnance map, the topography of which is often inexact. In parts certainly it has been done on six-inch maps and then reduced to the one-inch scale, for publication, a task of some difficulty where the old one-inch maps had to be used. A survey of the Drift in the London area on the six-inch scale is greatly needed.

It was only in the North of England, where the Ordnance Survey is of later date (as well as in Ireland and Scotland), that the one-inch maps were reductions from those on the six-inch scale; but here the Drift has not been published in all cases.

Now, however, several of the new one-inch maps of southern parts have been published by the Geological Survey. In these not only have divisions of the Drift been shown, and for the first time (except in parts of Sussex, where the new work had been reduced also on to the older maps), but also great additions and many alterations have been made in other respects, many details of division appearing for the first time. The counties of Dorset, Hants, and Sussex, as well as parts of South Wales have thus benefited, and others will soon have the like advantage.

It is not generally known, I think, that though the six-inch maps, on which the new work is done, are not published (except in the case of coal-fields), yet MS. copies thereof can be had, at the cost of making them. Sanitary authorities should avail themselves of this important help.

Since the above was written I have been favoured with a proof of a Geological Survey Memoir, entitled "Soils and Sub-soils, from a Sanitary Point of View; with especial reference to London and its neighbourhood," by Mr. H. B. Woodward. After a general geologic introduction it treats of the soils and sub-soils of London and a large tract around, the geological formations referred to extending downward to the Hastings Beds, and the following subjects are dealt with:—The Sub-soil in reference to Sites for Houses; Water-supply and Drainage; General Sanitary Conditions with regard to the Situations and Surroundings of Houses and Cemeteries. It seems to meet the wants of the many enquirers after healthy sites for houses, and should have a rapid sale, if only Government would make its existence known. As sanitarians we must hail this new departure and hope that this first attempt may lead to further work of the sort.

The importance of the Drift in questions of water-supply has been alluded to at various times and for various districts. As regards part of the Chalk-district the subject was brought before The Sanitary Institute, at the Portsmouth Congress, in 1892.

In many cases waterworks are on more or less impermeable beds, the water being got by shafts or borings carried down through these to underlying water-bearing beds. In such it is clear that Nature has herself provided a protected area, though often one may have to look beyond this, according to the distance at which the water-bearing beds rise up to the surface.

Where waterworks are placed on the beds from which the supply is got, such as the Chalk or the New Red Sandstone (our great water-bearing formations), or on overlying permeable beds, without any intervening impervious ones, it is obvious that the risk of pollution is greater and the desirability of a protected area essential. In such cases no source of pollution should be allowed to be set up within easy range of the source of a public water-supply, and any causes of pollution already existing should be got rid of as soon as possible. All the larger sources of pollution should indeed be kept as far from waterworks as possible; to say that none should be allowed to exist anywhere on any great water-bearing bed is to soar from the regions of the practicable into the sphere of poetry. The getting of good water and the keeping it good are amongst the

most important things we have to do; but they are not the only things.

These remarks, it will be seen, refer to water got from underground, by wells and borings; but they apply also to the case of springs, which are only the outflow of water that has been previously more or less underground. To extend them to those supplies that are got from lakes or streams would involve many other considerations, and some of a far wider kind. We must be pleased that the late Royal Commission on Metropolitan Water Supply has seen the advisability of greater control, by Conservancy Boards, over the rivers that give the chief supply to our great city; and it seems to me that without this greater control, the seven large companies taking this supply are put in an unfair position. I can never understand why in these matters the Lee should be separated from the Thames, for the former is just as much a part of the latter as any of the many other tributary streams, and probably would have been considered so had it not been for the fact that it was separately and specially taken for the supply of the oldest of the seven companies. I am far from wishing to disestablish our Fellow, Major Flower, who is so energetic in looking after the Lee (especially after the address that he gave at the Congress, p. 317); but surely it is time that the division should cease, and that the whole of the Thames should be under one strong Board.

In an address to this section, given eleven years ago, and in this same county, I alluded to various proceedings that had come before me and which seemed inadvisable in view of the probability of the contamination of water. Since then I have seen few cases of this sort of thing of importance: on a very small scale of course they are common. One however much astonished me, and it should, I think, be noted.

On a late visit to Tunbridge Wells, an inland health-resort, I accidentally came across a place, on the northern outskirts of the town, where sewage was allowed to flow into an old pit in the rock-bed of the Tunbridge Wells Sand. The quantity flowing in was probably small, but apparently the flow must have gone on for some time, as the crude sewage seemed to have clogged the pores of the fine-grained sandstone, and any cracks or fissures in it; so that a pond of liquid sewage, of an odorous character, was formed in the bottom of the pit. Presumably a great deal more fluid had filtered in through the rock than had remained behind. It seems lucky that the tract of Tunbridge Wells Sand from which the town is supplied with water is separated from the place referred to by a valley, cut through to the underlying clay. My visit was a very short

one and left me no time to follow up this interesting subject; but I think that there is no underground flow toward the much-frequented mineral well in the town, a mile or so southward. What I wish to enforce however is that though no harm may be done the proceeding is, at all events, of doubtful expedience. [I am glad to hear that practically it has ceased. Oct., 1897.]

Another and smaller case, of which I have heard only lately, is of interest as having been set up by a powerful body which, perhaps, ought to have known better. A new station has been built for the Metropolitan Police in the bottom of the Chalk Valley at Kenley, in Surrey. It had to be provided with a cess-pit, there being no drainage-system there, and this has been made more than 30 feet deep, so as not to need emptying. It is well that this is below instead of above the East Surrey Waterworks; but it is to be hoped that the District Council will take some steps to make the Metropolitan Police move on, in a sanitary sense. The County Council, unfortunately, has no power to interfere, or I should imagine that Dr. Seaton would have something to say.

It is more pleasant to turn to cases where preventive measures have been taken. Such a case has lately occurred at one of the largest of our southern provincial waterworks, where the possibility of contamination has led to extensive work being taken to avert it. At the Bedhampton Station of the Portsmouth Water Co. the powerful springs from which the supply is got have been bordered by a polluted stream, at a lower level. No proof of communication has been found; but the presence of a bad neighbour has been got over by diverting the stream into a line of iron pipes, 5 feet in diameter, for a distance of more than half-a-mile, beginning some way above the works, where communication with the Chalk is cut off by a thick mass of overlying clay, and running southward to a tidal creek below them. I believe that (with the exception of some pipes of 6 feet diameter, along the New River) this is the biggest set of pipes in the kingdom, though, of course, nothing particular in length.

Some of the London Companies, adopting the Report of the Royal Commission, have greatly extended, or are greatly extending, their storage-reservoirs and their filtering-beds, thereby not only ensuring a larger supply, but also a better one. There is no need now to enforce the advantage of filtration in such cases.

One may allude to a cause of damage to water common to supplies along the coast, the drawing in of sea-water. This is not pollution; but when it goes beyond a very small amount it is disagreeable and expensive, the water becoming practically useless for many purposes. The most notable case, and one

which has been much before me for some time, is **Eastbourne**, a watering-place of deservedly high repute, but which has probably suffered a good deal for some two years past, by reason of a considerable amount of sea-water having got into the public supply. The works are no great way from the sea, but they supplied the population for many years satisfactorily. Great increase of population led to much-extended pumping, and, after a set of dry seasons, drawing in of salt water followed. This, unfortunately, was strengthened by an extension of works, one of the galleries having been driven into a much fissured rock, the fissures having presumably a fairly free communication with the sea.

The Water Co. took steps to cut off the specially offending gallery, and was forced to keep down the water in it by extensive pumping to waste. It annexed a set of springs from the base of the Middle Chalk on the coast, at **Holywell**, westward of the town, which yielded nearly half-a-million gallons a day, from which source a separate supply was given (for potable purposes) for some time. A trial was made, though unsuccessfully, to get a supply, by deep borings, from the Lower Greensand, that formation being found to be so thin as to be practically of no account. Water was also taken from the Lower Chalk by a shallow well near the foot of the escarpment in **Wannock Glen**, north-westward of the town. Finally, having secured a site in a Chalk valley near **Friston**, larger works were begun there, and, as I write, this water is being delivered into the town by a temporary line of pipes carried over the high ground of the Chalk escarpment.

I am glad to be able to note these cases of Water Companies doing their duty to their consumers at great trouble and expense. Those of us who may have a general feeling in favour of corporations having the control of the water-supply should not let that blind us to the fact that companies can carry on their work properly, and in some cases probably better than corporations could, for there are cases where a company can do work more quickly and can spend money more freely than is in the power of a locally elected body.

Having succeeded, in the above remarks, in getting outside the boundaries within which they should have been kept, one is tempted to continue the process of straying further afield from one's own wide domain, and to notice a question of public policy, which seems to be unprovided for by any of our sections, and so may fairly find a place in the chemico-meteorologico-geologic dust-bin, especially as the first and last of the three sciences generally claim that all earthly knowledge comes within their respective territories.

It seems to me that one of the lessons that ought to be learnt from the Parliamentary Bills above-noticed is the advisability of some sort of federation in the matter of water-supply in many places. One saw the not over-edifying spectacle of a number of authorities scrambling for water from the same source, geologically, and got or to be got by the same means: every man's hand against every other man! As a matter of fact there seemed to be plenty of water for all, with available sites for getting it. If the various authorities who have to get their supply from the common source, in this case the New Red Sandstone, could only be brought together in some bonds of brotherhood much expense might be saved to all.

In the case of companies, formed solely for the supply of water, this could be brought about by fusion. As an example of a widely extended business of this sort the South Staffordshire Waterworks Co. may be instanced, its district having a length of 40 miles, with a breadth up to 20, the area being about 276 square miles. This includes 48 towns or parishes, amongst them being Burton-on-Trent, Cannock, Darlaston, Dudley, Smethwick, Tipton, Walsall, Wednesbury, and West Bromwich, the total population being over 560,000, of which about 460,000 probably are supplied, the water being mostly from deep wells in the New Red Sandstone.\*

In the case of corporations and councils this fusion of course cannot be made, their work including so many things besides the supply of water, and some of these being of exceptionally local interest. It often happens, however, that a town supplies more or less rural districts around it with water, or takes their sewage. One does not see therefore why a set of towns or other local authorities should not be able to combine for the purpose of having joint-works, whether by the formation of a Water Board or in what other method, being a question to be settled after due consideration. This is sometimes done in comparatively small cases; but one would like to see it extended to larger examples and to include existing works.

Perhaps the most peculiar case in the kingdom, as showing the need of combination, is that of the chief city, wherein eight companies hold divided, but often concurrent, sway, their districts overlapping in a most elaborate way. We have many Londons! a City of London, a Municipal London, a Water London, a Postal London, a Police London, a Registration London, and perhaps other Londons, with boundaries that are anything but coterminous. From the point of view of those

---

\* Presidential Address, by Mr. A. Hill, the Company's Engineer, to the Association of Waterworks Engineers, 1897.

who prefer that the water-supply should be in the hands of a company rather than under the control of a corporation, it would surely not be held that in the multitude of companies there is wisdom. I have long wondered why the London companies have not strengthened their position by some amount of combination. A federation for the northern side of the Thames, and another for the southern, would have been of great advantage, and is as much division as there should be.

Of course the suggestion of federation in the matter of water-supply will be met with the plea that there are many and great difficulties to be overcome; but difficulties may be defined as things that have to be overcome. We have a good stock of engineers, financiers, and such like, whose chief object is the getting over difficulties, and who are useless if they can't effect that object. I was about to include lawyers, but abstain, in deference to the opinion of many, that their function is to create difficulties, a view which I don't altogether hold myself.

Though one may almost despair of seeing any change in the number of water-authorities as regards London, surely in many cases our corporations and councils, urban and rural, can do something in the way of agreement amongst themselves, for the benefit of the public which they represent, and in this work the County Councils, with their wider range, should help. One of the healthiest developments of our public life of late years is the increased regard for local government, whether by Counties, Municipalities, Districts, or Parishes. We may surely expect this to have a good influence on public water-supply and other sanitary questions.

In the matter of combination this Congress, and especially this Section of it, may be taken as a good example. We are here as the representatives of distinct pursuits, banded together not for the special interest of each, but for the good of all, in joint work for the public good. We are divided into three Sections, and this one has again a triple division. In our work we may, I hope, adopt the motto that goes with the three-legged emblem of the Isle of Man, *Quocunque jeceris stabit*.

*Postscript, October, 1897.*—The need for some protection of sources of public water-supply, whereby their contamination may be avoided, is being strongly shown by the outbreak of enteric fever at Maidstone, the only apparent cause of which is polluted water. The number of cases has reached to over 1600, and the disease has spread to other places.

---