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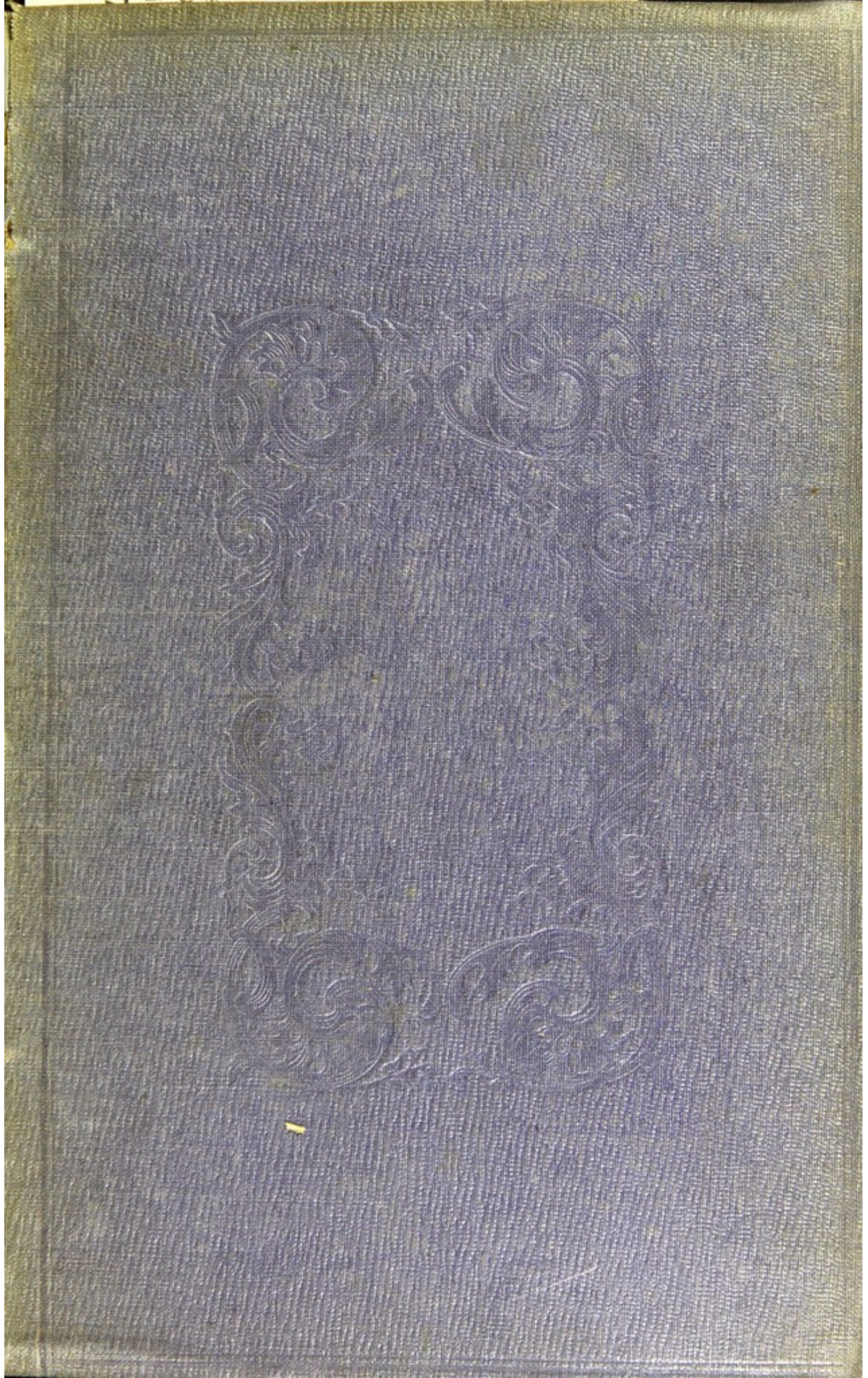
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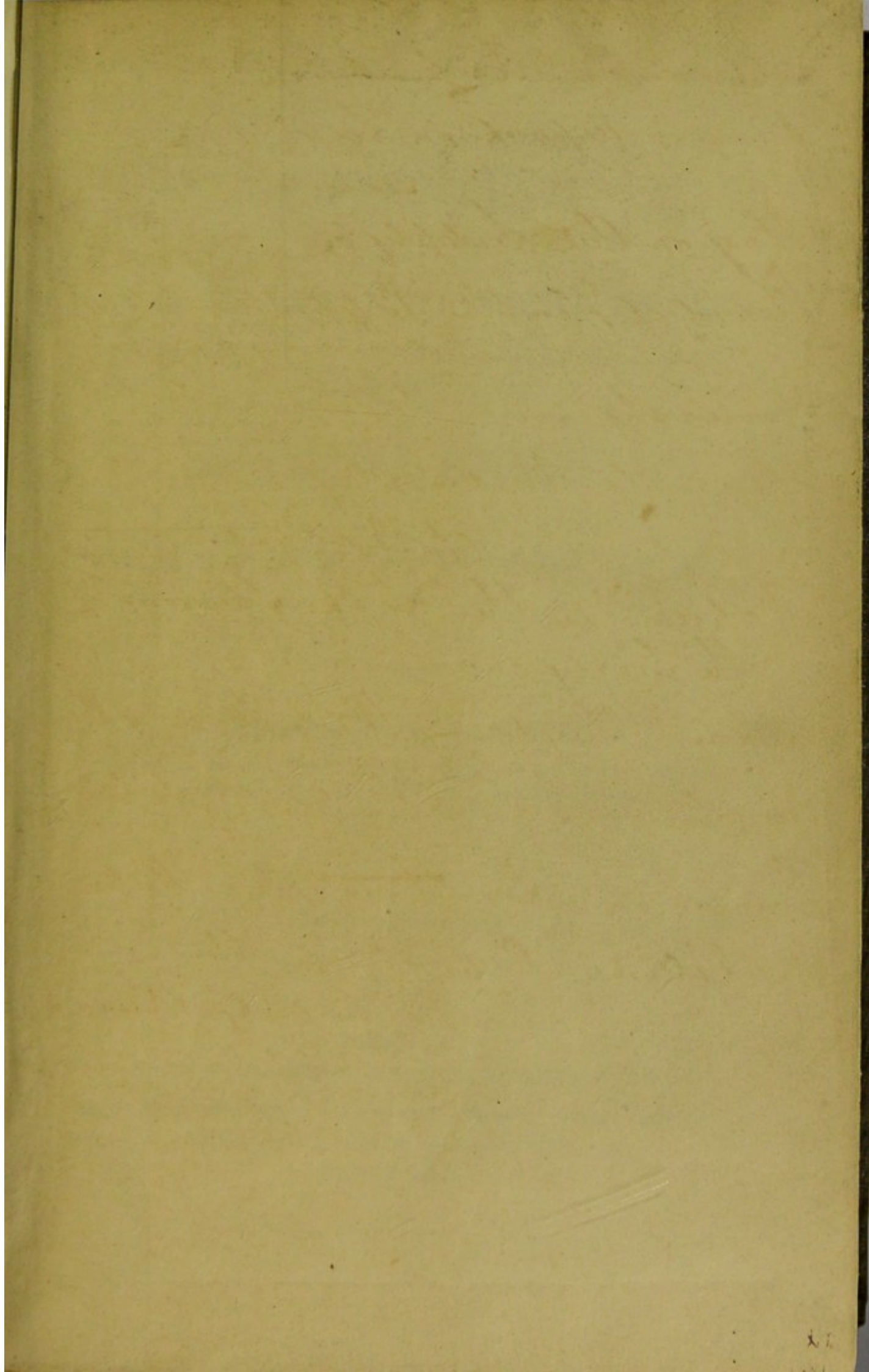
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REMARKS

ON THE

WATER SUPPLY

OF

LONDON.

BY

SIR WILLIAM CLAY, BART. M.P.

CHAIRMAN OF THE GRAND JUNCTION AND SOUTHWARK AND VAUXHALL
WATER COMPANIES.

ROYAL COLLEGE
OF
PHYSICIANS
OF
LONDON

LONDON:

JAMES RIDGWAY, PICCADILLY.

1849.

W. A. R. S. P. M. Y.

W. A. R. S. P. M. Y.

LONDON

SIR WILLIAM ARMY, BART. M.P.

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LONDON

JAMES BIRDAWAY, PRINTER

INTRODUCTORY NOTICE.

THE water supply of the Metropolis is a subject sufficiently important, even apart from the adventitious interest with which the recent epidemic has invested all questions touching the sanitary condition of the community, to preclude the necessity of any apology on my part, for calling the attention of the public to the statements contained in the following pages.

Having for some years taken much part in the management of two of the metropolitan water companies, I have had the opportunity of becoming possessed of information not generally accessible, and it seems to me, that at the present moment it may be useful to make that information more widely known. That on a subject not devoid of complexity, and not lying within the ordinary routine of men's thoughts or occupations, much misapprehension should prevail—is no more than might have been expected—but it is not a little important that all such misapprehensions should be dispelled, if we are about to take any steps with regard to this matter. We may, otherwise, instead of applying ourselves to effect those improvements which

are really required—fall again possibly into the errors of the early part of the present century,—errors of which the consequences would be alike injurious to the public, and to those whose fair interests I feel justified in advocating.

I have learnt with much pleasure, that the Commissioners appointed by the Crown, to inquire into the sanitary condition of the Metropolis, are at length turning their attention to the question of the supply of water. Had the result of their inquiries been already before the world, it would have superseded the necessity for the present publication,—but their Report will not be the less valuable or opportune, if the public have been previously furnished with some information on the questions to which it will relate, while I shall have the satisfaction of feeling, that if my statement of facts have been inaccurate, or the conclusions drawn from them unsound, but a short period will elapse before any mistakes into which I may have fallen will be set right.

*Fulwell Lodge, Twickenham,
15th December, 1849.*

WATER SUPPLY OF LONDON.

CHAPTER I.

HISTORICAL NOTICE OF THE WATER SUPPLY OF LONDON.

It may be useful to preface the statement of what the water supply of the Metropolis now is, by a brief notice of what it has heretofore been. The first water works, properly so called—for previously to their establishment, the only supply had been from wells and conduits, were those at London Bridge, constructed by a Dutch Engineer, in the reign of Elizabeth. The water was pumped by wheels turned by the tide, and supplied the city of London, and a small part of Southwark. After being in existence 250 years, the works were in 1822 purchased by the New River Company, by whom the London portion of the district is now supplied.

The New River Company, founded by Sir Hugh Myddleton, in the early part of the reign of James the 1st, completed in 1613—with the assistance of that monarch—the enterprise, then an arduous one, of bringing the waters of the Chadwell and Amwell Springs, from the neighbourhood of Ware, for the supply of London. Subsequently it was found neces-

sary, partly to compensate for the loss of the Amwell Spring (the smaller of the two which had abandoned the New River, and found its way into the Lea,) and partly to supply the increasing demands of the metropolis, to take water from the River Lea.

The Chelsea Water Works Company was established in 1723, and drew its supply of water from the Thames at Chelsea.

The York Buildings Company founded about the beginning of last century, and drawing their supply from the Thames opposite the Adelphi, were ruined in the long contest which commenced in 1810. Their pipes were bought in 1818 by the New River Company, who now supply the district.

The East London Company was established in 1807, to supply London with water from the Lea at Bow, near to its confluence with the Thames.*

The West Middlesex Company established in 1806, took their water from the Thames at Hammersmith.

The Grand Junction Company, established in 1810, to exercise powers of water supply originally granted to the Grand Junction Canal Company, at first took their water from the Canal—subsequently, by agreement with the Regent's Canal Company (to whom they transferred their right of water from

* The Company at its first formation purchased the Works of two small Companies, the "Shadwell" and "West Ham," which had for many years supplied a portion of the East of London.

the Grand Junction Canal) from the Thames at Chelsea.

On the south of the Thames, the Southwark Company, originally an offset from the London Bridge Water Works, was first incorporated as a separate company in 1822, and then drew its supply from the Thames near London Bridge.

The Vauxhall Water Works Company established in 1805, took their supply first from the Effra river and subsequently from the Thames at Vauxhall.

The Lambeth Company, established in 1785, took their supply then, as at present, from the Thames, opposite the Adelphi.

The two former South Metropolitan Companies, the Southwark and the Vauxhall, were united by act of Parliament, in 1845, forming thenceforward one Company—the Southwark and Vauxhall Water Company.

All the Companies north of the Thames, were engaged from 1810 to 1819, and those south of the river to a later period, in contests to which I shall hereafter have occasion to refer more at large; I will at present merely say, that on the termination of the competition, the Companies that survived the struggle restricted their operations to the districts they now respectively occupy.

In 1828 circumstances, with which it is unnecessary to trouble the reader, first attracted the notice of the public to the quality of the water supplied to London; for strange as it may

appear, it is nevertheless true, that the quality of the water had never up to that time seriously engaged the attention either of the Legislature, or the Public. At the instance of Parliament a commission was appointed to inquire into "the state of the Supply of Water in the Metropolis." No legislative interference followed the Report of the Commissioners; but as it had become clear, during the course of the investigation, that amidst much that was untrue, and much that was absurd, sufficient evidence was given to shew that improvement was necessary, the Companies themselves undertook to effect it.

The Grand Junction Company, the character of whose water had been most impugned, removed the source of their supply from Chelsea to Kew, and formed reservoirs of deposit and filtration on the Middlesex shore of the river.

The West Middlesex Company purchased land at Barnes, and constructed large reservoirs there, taking their water by a pipe across the River,—they also formed a reservoir on Primrose Hill.

The Chelsea Company formed deposit and filtering reservoirs at Chelsea, and it is to the able engineer of that Company, Mr. Simpson, that we owe the first available form of filter on a large scale.

The New River Company constructed extensive reservoirs (not much less, I believe, than forty acres), at Stoke Newington, discontinuing wholly a supplementary supply, which they had theretofore

occasionally drawn from the Thames at Broken Wharf, in Thames Street.

The East London purchased the Lea Bridge mills, and formed a canal to bring the water to large reservoirs which they constructed at Bow, to avoid using any water which had been subject to tidal influence.

On the south of the Thames, at a somewhat later period (for the competition there continued longer), the Southwark and Vauxhall Companies having been, as before-mentioned, amalgamated, the supply of the united Company was taken at Battersea, where large reservoirs of deposit and filtration were constructed.

The Lambeth Company formed reservoirs at Brixton Hill.

These various works, undertaken, not with the view of increasing the revenues of the Companies, but of improving their supplies, either in quality or abundance, or of obtaining a greater power to afford water for the extinction of fires, have cost in the aggregate considerably above half a million of money.*

* It is curious to observe how thoroughly the public seem to be in ignorance of what has been done in this respect by the Companies. The prevalent belief apparently is, that *no* increase or amelioration in the supply of water has taken place for the last twenty or thirty years. The fact being that, within that period the supply has doubled, far outrunning in that respect the ratio of increase of the population, while in almost all essential particulars the character of the supply has been

The Companies now supplying London are—on the North of the Thames five—the East London, the New River, the West Middlesex, the Grand Junction, and the Chelsea, on the South of the Thames two, the Southwark and Vauxhall, and the Lambeth, and their districts respectively as follows. The East London Company supplies the East of London, from the Lea to a line extending from the Tower to Stamford Hill. The New River, the whole of central London, from that line to Charing Cross, and northwards by Tottenham Court Road to Camden Town. The West Middlesex, the district west of Tottenham Court Road, and north of Oxford Street. The Grand Junction, the whole of St. George's, Hanover Square, north of Piccadilly, some small portion of St. Marylebone, the larger part of Paddington, and St. James's to Pall Mall. The Chelsea supplies the West of London, from the boundary of the Grand Junction to the Thames.

On the south of the river, the lines of demarcation are not so complete—the districts being much intermixed—but generally, it may be stated, that the Southwark and Vauxhall Company supplies the Borough of Southwark, and the parishes lying eastward of the Borough as far east as Rotherhithe, and completely changed. These misconceptions are partly the fault of the Companies themselves, who would have judged wisely—as they certainly would have been justified—in making known to the public the improvements they had effected.

south as Camberwell. Adjoining their district on the west, the Lambeth have a district touching the Thames, comprehending the larger part of Lambeth, and extending southward to Brixton, beyond which district again the Southwark and Vauxhall Company supplies portions of Lambeth and Clapham, and the whole of Battersea.

All the Companies are corporations in perpetuity, they have no exclusive rights as regards either the public or each other, and no other restraint on running pipes into each other's districts, than the prudence generated by a bitter recollection of the results of their former hostilities.

Among them, four have a parliamentary scale of rates, the others have no limitation.

CHAPTER II.

ON THE QUANTITY OF WATER SUPPLIED.

“ THAT the water at present supplied to London is bad in quality and deficient in quantity, and that in consequence of such deficiency there are 70,000 houses, and from 600,000 to 700,000 persons, in the metropolis without a supply at all,”—such is the substance of the statements on this matter which have been widely promulgated within the last few months, which have found their way into the prospectus of every new Company, and formed the staple of the resolutions submitted to every meeting. The present chapter will be devoted to testing the accuracy of these assertions, as far as they relate to the sufficiency in quantity of the present supply.

The mean quantity of water per month delivered to London in the present year by the five companies north of the Thames, viz. the East London, the New River, the West Middlesex, the Grand Junction, and the Chelsea, and the two on the south, the Southwark and Vauxhall, and the Lambeth, has been 1,355,790,047 imperial gallons, or at the daily rate of 51,979,171 gallons for six days in the week,—a Sunday supply being rarely or never given.* If to contrast this supply with a

* When the Henley Water Works Bill was before Parliament last Session, the Companies stated their daily supply at 60,000,000 gallons. It may be well to explain therefore, first, that in that amount were comprehended the supplies given by the Kent and Hampstead Companies, which supply portions of what is ordi-

supply on the "continuous system," which would of course include Sundays, it be spread over seven days, it gives a mean daily supply of 44,573,919 gallons. The aggregate numbers of tenants of the Companies are 259,668, and the daily supply, therefore (for seven days in the week), 172 gallons to each house or tenement. The average number of inhabitants to each house in London is, by the Registrar-General's returns, 7.5, and the daily supply, therefore (also for seven days in the week), is at the rate of 23 gallons per head. Some deduction from the mean rate of supply per head must be made for the quantity of water consumed in street watering, in flushing sewers, and also for the extra supplies taken by what are called "large consumers,"—Railway Companies, Hospitals, Manufacturers of various sorts, Tanners, Brewers, Distillers, &c. I have not the means of estimating precisely the amount to be subtracted on these grounds from the supply given to individuals by all the Companies; but I have the means of doing so precisely

narily considered the metropolis, although I have not included them in the present view, and secondly, that the quantity stated was the aggregate amount of the supplies then given,—the quantity mentioned in the text is the mean of the whole year. The supplies occasionally given (in hot and dry seasons, for instance such as the summer of 1848), greatly exceed not only the mean, but the 60,000,000 gallons. It may be right also to mention that the mean above stated is from the quantities actually delivered in 1849 by all the Companies except the East London, with respect to which Company I have only the quantity delivered in 1846; but as the present number of their tenants (which has increased by more than 2000) is included in the aggregate of tenants above given,—the tendency of the error, if there be any, must be to lower the mean in some trifling degree.

with regard to two—the Grand Junction and the Southwark and Vauxhall,—and the same ratio of calculating the deduction, or nearly so, would no doubt apply to the others.

Both those Companies would appear to deliver above the average quantity; the Grand Junction probably, from the district it serves comprehending a considerable portion of that part of the Metropolis where there are the largest houses; the Southwark and Vauxhall, because within its district is to be found a greater proportion of those trades,—tanners, curriers, &c.—which require a very large supply of water. The supplies they give respectively are as follows:

The Grand Junction, 3,541,716 imperial gallons per diem to 14,058 tenants, or 252 gallons per house for seven days in the week, which, taking the average number of souls per house as nine in the district it serves, gives 28 gallons per head,* deduction being made for the extra services referred to (comprehending in this case scarcely any trades, and consisting chiefly of street watering, railways, and flushing sewers) the daily supply will be 223 gallons per house, or 25 gallons per head.

In the Southwark and Vauxhall districts the gross supply per diem for seven days in the week, is 6,011,225 gallons to 35,511 tenants, or 169 gallons to each, and taking the average number of

* In the Registrar-General's returns, the population per house of St. George, Hanover Square, is given as 8·7; of St. James's, Westminster (which forms but a small portion of the district), as 10·3. I have taken 9 as a fair mean.

souls per house in its district at $6\frac{1}{2}$ —26 gallons per head,*—and deduction being made in like manner, the net supply 143 gallons per house, or 22 gallons per head.

But to ascertain whether London ought to be considered as well or ill supplied, it is not of course enough to state the amount of water actually given; it should also be known—

1st. What quantity is required for the wants of the inhabitants; and

2ndly. By way of comparison, what are the quantities supplied to other towns.

With regard to the first point, we have it fortunately in our power to refer to an unquestionable authority. I allude to the report of the “Commissioners for inquiring into the state of large towns and populous districts.” In their second Report, pointing out the remedial measures required, they say, “in all cases where an ample supply can be procured, we think it ought not to be calculated at a less rate than 12 gallons per diem for each individual of the population.” This quantity, as they afterwards explain, to be exclusive of the water necessary for flushing sewers, and watering streets.

The great care with which the inductions con-

* From Registrar's Returns :—

St. Saviour's and St. Olaves	.	7.2
Bermondsey	.	6.2
St. George, Southwark	.	7
Newington	.	5.8
Lambeth	.	6.5
Camberwell	.	5.8
Rotherhithe	.	5.8

tained in that very able document have evidently been made, would seem to render superfluous any attempt at corroborating the conclusions arrived at by the Commissioners; but as it happens to me to have a very good opportunity of testing the accuracy of the above opinion, I may be permitted to state the result of the experiment. In a large household in the country where, from the water required for daily use being pumped into the dwelling, not by manual labour, but by water-power, there is no motive for economizing the consumption, where there is a warm bath, and both hot and cold water laid on to the upper floors, the mean daily supply for ten weeks was at the rate of $13\frac{1}{2}$ gallons per head. The number of inmates, including the members of the family and servants, was twenty-four.

As the experiment was made with great care, and as from the circumstances which have been mentioned, there can be little doubt of the consumption being above the average, it may be considered as no slight corroboration of the conclusion of the Commissioners as to the quantity of water required for domestic use. Indeed, any one who will take the pains to ascertain the utmost quantity of water an individual requires day by day—for every possible purpose of cleanliness and comfort—will find that a supply of twelve gallons to every member of a household, will leave a surplus abundantly sufficient for all other purposes, either in a small or large family.

Upon this estimate then—the inhabitants of London supplied by the Water Companies—should have 23,370,120 gallons daily, but as we have seen they receive 44,573,919 gallons, or a quantity nearly two-fold greater than would be amply sufficient.*

If again we look to the quantity furnished to any other city, we shall find none of which, as far as I am aware, the supply approaches in quantity that given to London. Nottingham has been thought to be well supplied, the quantity given is stated to be eighty to ninety gallons per diem, to each of 8000 tenements, or about twenty gallons per head, to a population of 35,000, but in the 8000 tenements are included “breweries, dye works, steam engines, inns, and other places of large consumption.” In Glasgow the supply was equal (some years since at least) to 13 gallons per head. In Greenock and Paisley, it is now at the rate of 12 gallons.†

* To render this comparison quite exact according to the conditions stated by the Commissioners, the quantity of water used for flushing sewers—or street watering—during a portion of the year should be added to the smaller or deducted from the larger sum, but I have not the means of doing so with accuracy.

The largest possible allowance, however, on this head would not make any very important difference in the results above stated.

† At Preston the average daily supply is at the rate of 75 gallons to consumers (tenants) of all classes, 45 gallons being the estimated quantity for domestic use, and 902 gallons for each manufacturer. I do not know the amount of the population. In all the towns that have been referred to, the supply is on the “continuous” system.

Turning our attention to other countries, or rather the only foreign country where any supplies of water, of the nature of those to which we are accustomed, are given : *viz.* America,—we find the supply of Philadelphia always spoken of in terms of admiration. What are the facts with regard to it.* It seems that in the year 1843, the daily supply amounted to 4,000,000 gallons. The population was 240,000, and the supply per head therefore equal to between 16 and 17 gallons, and “only some few dwellings have it laid on up to the attics.” But in one London district (the Grand Junction), the population being in 1849 126,000, there were, as we have seen, 3,541,716 gallons, or 28 gallons per head given to the inhabitants.

In the same portion of the Appendix to which I have referred are replies to queries from New York also. The daily supply is not given, but as the population is stated at 312,000—as there are only 150 miles of main, as in “only half the houses using the water it is carried through the house,”—as the larger portion of the inhabitants take their supply from hydrants (standpipes ?) and wells, there can be little doubt, but that the supply is in a yet greater ratio than at Philadelphia, inferior to that of London. I may here notice by the way, that great stress is laid in the replies both from Philadelphia and New

* See Appendix to First Report of “Commissioners for Inquiring into the State of Large Towns,” &c. Vol. 2. page 136.

York, on the advantage to those cities from the ample supply of water now afforded for the extinction of fires. The rates of fire insurance have fallen in New York 25 per cent., in Philadelphia (if I rightly understand the answer) 33 per cent. in houses. But in this particular both those cities are yet far behind London, as the respective rates of fire insurance abundantly prove. In the Appendix will be found a comparative statement of the premiums of fire insurance in those cities and London respectively.*

From the facts that have been adduced, it is impossible to avoid coming to the conclusion, that water is furnished to London not only in greater profusion than to any other city in the world, but in a degree beyond the utmost wants of its inhabitants, and when to this is added—that the Companies could if it were required, easily double their present supplies, it must, I think, be considered as demonstrated, that whatever may be the other improvements required, no outlay of capital could well be more purely in waste, than one devoted to bringing more water to the metropolis. Of this vast supply a great portion no doubt is wasted, and there is also unhappily no doubt but that simultaneously with this waste, the poorer inhabitants of the Me-

* I have been disappointed in getting an exact statement of the rates of insurance, in Philadelphia and New York, but I believe they will be found to exceed, by not less than from one to two hundred per cent, the London premiums on all classes of risks.

tropolis often experience a lamentable deficiency of this first necessary of life. Of the causes by which this state of things is produced, and of the means by which it may be remedied, I am about to speak; but my object hitherto has been merely to show that whatever want of water may be felt in any part of London, it does not and cannot arise from the inability of the Water Companies to give a sufficient supply.

I know not on what authority the statement rests, that there are in London 70,000 houses without a water supply. That in London and its suburbs, within the utmost sweep of the mains of the different companies, there are many houses very ill supplied (houses in courts for instance, with no other supply than from a common tap), and many more supplied, not by any water company but from wells, I know to be the truth; but that there are 70,000 houses without any supply I greatly doubt. It is at least not consistent with facts which come under my own observation. In the Appendix (No. I.) will be found stated the results of an examination on this point, instituted in two districts, one in the wealthier, and the other in the poorer portion of London, comprising together one-fifth of the Metropolis.

Whatever may be the truth, however, in this matter,—whatever the real amount of this insufferable social evil—there is not the very shadow of a foundation for imputing the blame of it to the

Water Companies. It exists not only without any fault or negligence of theirs, but in despite of their earnest and incessant efforts to prevent it, and this will be readily believed, when it is recollected that by such a state of things, they are constant sufferers. It is a positive loss to a Company not to supply every house, even of the humblest class, where their mains are laid. All the great items of expense, the formation of the works, the laying down the mains, have been already incurred—a very large portion even of the annual expenditure, must be borne, whatever be the amount of income; to serve the whole of a street, will scarcely cost more than serving half of it. Up to a certain point, the revenue of a Water Company merely defrays its current expenses, it is only when the income rises beyond that point, that it yields any interest on capital. That the Companies therefore, should be earnest in getting tenants, will not be matter of surprise—nor that they should prefer giving to each a separate supply, rather than supplying a tap common to several—when it is recollected that of all modes of supply, that by common taps is the most wasteful. The efforts of the officers of all the Companies, I believe, are strenuously directed to get rid of them. I can answer for those with which I am connected. The Southwark and Vauxhall Company, have of late years refused to give any new supply in that mode—and, in the case of old supplies, no greater rent is

charged for a supply given to each house, than when the inmates have only the use of a common tap. The difficulty, notwithstanding of first establishing a water supply in poor neighbourhoods, or improving one that already exists, would be scarcely credible to any one not practically conversant with the subject. The occupants of the houses, mostly weekly tenants, cannot incur the expense, trifling as it is, of laying it on, and the landlords will not. Nor must it be supposed that this reluctance arises from the onerous amount of the rate. The Southwark and Vauxhall Company have 8,782 tenants, at rates varying from 4s. to 10s. per annum—the mean being 6s. 11d. For this sum each tenant has, or may have an ample supply (for no limit is put on the size of the cistern) of water perfectly bright at all times of the year and of quality (as I shall presently shew) that cannot be surpassed. I do not consider the “intermittent” so good as the “continuous” supply system, for the service of the poorer classes—but still a tank or butt full of good water, and renewed every day, would be an inappreciable blessing to a labouring man. The cost of a barrel which would hold thirty-six gallons, and the service pipe to connect it with the main, need not exceed 22s. 6d., and would be repaid in four years, by an addition of 1d. per week to the rent;* but this outlay the landlords will not incur, for the pur-

* $\frac{1}{2}d$ per week would give to the proprietor an annual interest of 10 per cent.

pose of giving a supply of water to their tenants, and the Companies have no power to enforce their doing so. If the Companies were to make the outlay necessary to connect the houses with their mains, they would have no legal power to recover the money so expended—nor indeed is it clear, that were they inclined to run the risk, the parties would avail themselves of it. In one instance, the Southwark and Vauxhall Company offered (although without any legal power of recovering either the principal or interest of the money so expended), to construct a tank which would give continuous supply to a block of 100 small houses, at the rate of 50 gallons per diem to each—if the proprietor would pay an additional rate sufficient to yield 5 per cent. on the outlay, such additional rate not exceeding $\frac{1}{2}d.$ per week for each house, but the offer was declined.

If the facts of the case be as above stated, and I know them to be so in the districts with which I am acquainted, and presume them to be so in all, if for no other reason,—because traders in water, as in any other commodity, must desire to augment their profits; then the inference is inevitable, that the want of water complained of in the dwellings of the poor is not attributable to the inability or disinclination of the present Companies to give a sufficient supply.

It cannot be too clearly understood, that there is no other mode of remedying this insufferable

social evil, than by lodging some where, in the hands either of the Water Companies, or of some municipal authority, a power to compel the proprietors of houses below a certain class to take a water supply at rates to be agreed on. But do I, in making this suggestion, mean it to be inferred that I consider the landlords of small houses as a peculiarly hard-hearted and avaricious class, and requiring beyond all other people to be coerced into humane behaviour? It would be mere drivelling to do so. The evil lies far deeper, and is of such magnitude, that I cannot forbear, remarking upon it. The truth is, that we have gone on improving London until we have left no room for the poor. We have almost, as our kinsmen across the Atlantic would say, "improved them off the face of the earth." Our vast city has grown on every side, with a rapidity almost portentous, and every step of its progress, instead of improving the condition of the poor, has diminished their comforts. We have provided houses in abundance for the rich, we have made no provision for the poor. We have ignored their existence. If we look at some new suburb, what do we see? noble squares, and wide streets, lined with splendid houses—what else?—mews for the carriages and horses of their inmates, and shops to supply them with necessaries, but where are the habitations of the poor? If, again, we look at the improvements in the heart of London, we find that where some new and com-

modious thoroughfare has been opened, it is always considered a matter for additional congratulation, that some "poor neighbourhood" has been destroyed, but what fresh site do we provide for the dwellings of those whose hovels we have levelled with the ground? The consequence of this state of things is, that almost every where, within the whole range of the metropolis, a labouring man finds the greatest difficulty in procuring a residence, and is obliged to put up with whatever habitation he can obtain, within any moderate distance of the scene of his daily labour, however mean, wretched, and comfortless. The demand so much exceeds the supply, that he has no choice; while, on the other hand, the owners of houses of this description, not unfrequently themselves persons of small means, finding they can always get tenants, feel no necessity for laying out money in what may probably seem to many among them superfluous improvements of property, which already yields a large return. Fortunately the remedy, to some extent, is within our power; it is as consistent with sound policy in every point of view, as it assuredly is with an enlightened benevolence, for those who have the means to engage largely in providing sites and building houses for the poor. Lord Ashley and others have set us an admirable example. Nor would this be a merely charitable project; if it were so, I should despair of its success—no great social reforms were ever accomplished by

the mere operation of benevolence ; such changes are only effected when they promote the interest of those who take part in them. This would be eminently the case in the present instance. I do not believe any investment of money would at this moment yield so good a return, as the providing dwellings for the labouring classes. Build a row of fine houses, and the chance is—they would stand tenantless—provide any number of separate dwellings or sets of apartments, at rents from half-a-crown to five shillings per week, and they will not remain empty a day after they are ready for occupation. Very large sums might, I am satisfied, be laid out with advantage in this way, and the example given would be yet more important than the actual good effected.*

If the facts which have been adduced appear to my readers in the same light in which they present themselves to my mind, they will agree with me in the conclusion,—that the reform required, to ensure to every inhabitant of the Metropolis a sufficiency of water, is not an enlargement of the supply but a change in the mode of its distribution, and in the legal provisions under which it is administered.

* The above passages were written before I had seen the Report of the meeting in Spitalfields, over which Lord Carlisle presided. It is with the highest gratification that I observe the progress which is being made in this most praiseworthy enterprise, and the terms in which it is spoken of by the leading members of the press.

Among the improvements in the process of distribution, I should certainly include the giving a "continuous" supply to the dwellings of the humbler classes—possibly under certain conditions—of all classes;—but this branch of the subject is sufficiently important to be treated of in a separate chapter.

CHAPTER III.

ON THE QUALITY OF THE PRESENT SUPPLY OF WATER.

THERE must be, I should think, even in our present feverish state of excitement on all sanitary questions, some few persons as well as myself, who calling to mind what used to be said of Sir Hugh Myddleton's great enterprise, and the ancient renown of the waters of the Thames, have been not a little startled by the very hard words lately bestowed on the water supply of the Metropolis. Of the vivacity of these attacks, however, I am not disposed on behalf of the Water Companies to complain, they will assist in drawing the attention of the public to a most important subject,—truth will be elicited by discussion, and I am quite satisfied that there can be no parties to whom it is of greater interest, that the whole truth respecting the water supply of London should be generally known, than to those by whom it has been hitherto administered.

What are the facts as to the quality of the water at present supplied to the Metropolis, and what are the improvements required in this particular? In entering on this inquiry, I need scarcely disclaim the remotest intention of disputing the right of

the inhabitants of London to the best supply which it is possible to procure,—I admit at once that if the present supply be not or cannot be rendered such, new supplies must be brought from some other source, at whatever effort, or by whomsoever that effort may have to be made.

London is supplied, as has been stated, from the Lea, the New River, and the Thames. The two former will require but little remark. By the statements of analysis in the Appendix (Nos. 3 & 4) it will be seen that the waters of those streams are of great purity as regards their saline ingredients, capable therefore of being rendered perfectly well adapted for domestic use by an easy process of depuration. My readers are of course aware, that water may be rendered impure and unfit for use by two causes, perfectly distinct in their character and operation,—by the character and amount of the salts in chemical combination with it, or by its holding extraneous matter in mechanical suspension. The former cause of deterioration is the more formidable as it cannot be got rid of by any process applicable to large quantities of water,—the second admits of easy remedy. All running streams will be found, more or less at all times, but to a greater degree of course in times of flood, to hold extraneous matter in mechanical suspension, and for this reason their water should always be subjected to filtration prior to delivery.

Filtration of the best kind, through a sufficient

thickness of sharp sand, though it has no effect upon matter held in chemical combination, will render water perfectly bright, it is in fact nature's own process of depuration, spring water being only rain water falling on the surface, and cleansed from the impurities thus acquired by filtration through different strata. The water neither of the Leaning nor the New River is subjected to this process, and I am satisfied, that in whatever degree the charges against the quality of the water served by the Companies which draw their supplies from those streams respectively are well founded, it arises from this omission. I do not believe that water taken from either of those streams, and perfectly filtered, would be pronounced by any competent authority other than unexceptionable for all domestic purposes.

It is no doubt true, that precisely the same effect of depuration may be produced by deposition, provided the process be carried to a sufficient extent. To take an extreme case, the Rhone, which enters the upper end of the lake of Geneva, a very turbid stream from the Valais, after reposing in that vast reservoir, issues at Geneva from the lower end of the lake, in a state of such transcendent brightness, that many travellers have fancied the water was blue from the perfection with which it reflects the colour of the sky. But for artificial depuration by deposit, time and space are always wanting, especially at periods of flood, and although the Companies to which I

have referred have depositing reservoirs, I do not think such provision sufficient to secure the water they serve, being delivered in a fit state to their tenants.

We will now turn to the Thames. And first, what is the character of its water when unaffected by extraneous causes? why, such as fully to justify its ancient fame. From the subjoined analysis (No. II. in the Appendix) it will be seen that its purity and salubrity as respects saline ingredients, are remarkable; so much so, that Dr. Pearson and Mr. Gardner, the eminent chemists employed by the Commissioners appointed by the Crown in 1828, "to inquire into the supply of water to London," state, as the result of their investigation, "that the impregnating ingredients of the Thames water, are as perfectly harmless as any spring water of the purest kind used in common life; indeed there is probably not a spring, with the exception of the Malvern, and one or two more, which are so pure as the Thames water."

But of what consequence, it may be said, is the character of the native stream of the Thames, as, before it is pumped up for the use of the inhabitants of the metropolis, it is polluted by all the drainage of this great city. We are about to see to what extent it is so polluted. From the constant reiteration of the assertion, on all occasions when the Thames is spoken of, that it must be an unfit source of supply, because it is "incessantly

washing backwards and forwards the drainage of London," one is almost led to believe that the speakers forget, that the first of English rivers, is already above Teddington, a very considerable stream. The average volume of the waters of the Thames, as they fall over Teddington weir—is 216,000,000 cubic feet,—a quantity of water which would fill the *entire* bed of the stream from Teddington lock to Battersea Bridge, to a mean depth of 5 feet 7½ inches.* The effect of the flood tide, therefore, anywhere above London, must be rather to check, and then roll back the native stream of the Thames, than to create an absolute reflux of the waters that had got so low as London, and that such is the effect produced, is apparent from the result of some experiments on the tides, of which a statement is given in the Appendix. All but the last of these experiments, were made prior to the removal of Old London Bridge, the last shows what has been the effect on the tides of that removal. It is such as might have been anticipated, the tides are stronger,—the flood in consequence ascends somewhat higher, but the ebb is more rapid, and it will be observed that the float reached the same point below Battersea Bridge (the

* This is probably understated, I have taken only the quantity estimated by Mr. Walker, in his report to the City Thames Navigation Committee, in 1841, to pass by Staines, but this he adds, "is much increased by the streams which afterwards join it, and still more by the springs which rise up under its course downwards."

old site of the Grand Junction works), in sixteen minutes less time than before London Bridge was removed.

Thus much is clear, that no water which has been as low even as Vauxhall Bridge, where the last large sewer of London* (the King's scholar's pond sewer) empties itself, ever returns higher than three-quarters of a mile above Hammersmith Bridge. Of course, as the above is the utmost point to which the reflux of water ascends, the intermixture of the drainage of London at any time of tide in the upper portion of the river within the range of that reflux must be altogether trifling. At Hammersmith, for instance, at high water, the river is full, not of water mixt with drainage from Vauxhall, but of the stream of the Thames pushed back by water that has been so mixt.

But again, in three hours and nine minutes, the whole of the water of which any portion had even for a moment been as low as Vauxhall, had ebbed back past the Red House and as the length of the ebb at Battersea is seven hours and forty minutes, there are considerably more than four hours during every ebb, and one probably at the commencement of flood, whilst the water rises without returning, during which the Thames at Batter-

* I might have said,—as bearing on the matter in hand,—the last sewer, for the Ranelagh sewer, just below Chelsea Hospital, which is the last, can have no influence during the ebb on the centre of the stream, still less on the opposite shore.

sea has no more to do with the drainage of London than with that of New York.

Now from what parts of the stream, and under what circumstances, do the Companies that take water from the Thames draw their supplies? There are five—the Grand Junction, the West Middlesex, the Chelsea, the Southwark and Vauxhall, and the Lambeth,—and they take their supplies in the order in which I have named them,—commencing with the highest in the stream. The Grand Junction draws water about a quarter of a mile above Kew Bridge, from the Surrey shore, and where a long range of islands separates the main body of the stream from Brentford, from which town, however, there is as far as I am aware no sewerage. Evidence was taken as to this site before a Committee of the House of Lords, when the Company applied for enlarged powers to raise capital in 1835, and by the Committee the site was fixed.

After the facts which have been adduced, it is unnecessary to say that the water drawn by this Company is as indisputably the mere stream of the Thames, as far as any admixture with the drainage of London is concerned, as if it were taken at Henley or Maple-Durham. The same may be said of the supply of the West-Middlesex, which is taken into their large reservoir a little below Barnes Terrace. Of course, as to the character of the water taken by both these Companies there can be no doubt or hesitation; but I do not believe that, except-

ing as far as the imagination is concerned, the water drawn by them is better than may be taken at Battersea.

The Chelsea Company draw their supply at Chelsea, nearly opposite the Red House at Battersea; the Southwark and Vauxhall at Battersea, a little below the Red House.

I have already shewn that during two-thirds of the ebb, the water that flows by that point, is unmingled with any London sewerage, and consists therefore of the stream of the Thames alone, for there is no drainage above London, capable in any appreciable degree of affecting it. A corroboration of this inference is to be found in the fact that the specimen of water taken by Dr. Pearson and Mr. Gardner, from the Thames at Battersea bridge at low water, was found to be identical in quality with that taken at Teddington.

The Southwark and Vauxhall Company's Works, are so constructed, that the whole supply can be taken during the last two-thirds of the ebb.* The

* In one important particular the Company's works are only now being completed, although with that exception, they were finished two years since. The spot in which the culvert pipe for taking water from the Thames, was placed, — was fixed with reference to an alteration in the form of the banks of the stream, which was a part of the Battersea Park plan; but so long a delay has occurred in putting this plan in execution, that the Directors have been under the necessity of extending the culvert, to avoid the deposition, which, when the shore

water is first raised into depositing reservoirs, and after from two to three days rest, is transferred to the filter beds, from which it is immediately distributed to the Company's tenants. The Chelsea, I am informed, only pump during the latter portion of the ebb, and their suction pipe is extended from the Middlesex shore, into the centre of the stream. Of course, when that diversion of the London drainage, from the Thames, which, without reference to the Water Companies, must inevitably take place, shall have been effected, there will be an additional security for the purity of the water taken any where within the tidal action,—but even under existing circumstances, it does appear to me, I confess, beyond the possibility of denial, that water taken with the necessary precautions at Battersea, must be considered as the mere stream of the Thames, and as such inferior in no appreciable degree to the stream in any part of its course.

The foregoing conclusions are fully borne out by

is irregular, occasionally takes place between high and low water mark. The mouth of the culvert pipe is now some distance beyond low water mark, in the bed of the main stream, and where the bottom, composed of gravel, is always perfectly clean. I may here remark that nothing would be easier than wholly to prevent any mud accumulating on the shores of the river. It would only be necessary to give the banks everywhere a regular form, and in some places to contract the bed. A plan for the accomplishment of this object was presented to the city in 1841 by Mr. Jas. Walker, and it is much to be regretted that it has not yet been carried into execution.

scientific investigation. In the Appendix will be found an analysis—bearing a name, the authority of which will be considered at least second to none—of Thames water as delivered by the several London Companies, and as taken from Medenham, whence it was to be derived by the Henley scheme of last year. By this analysis it is clear that the Henley water is not only not superior but that it is inferior, especially in softness (though certainly but in trifling degree) to that at present supplied to the Metropolis. This result was to be expected, there is no cause of deterioration above the London drainage, capable of effecting in any appreciable degree the vast volume of the waters of the Thames, while against the operation of any such conceivable cause, is to be set the well known tendency of rivers to become purer as they flow, as well by the action of the atmosphere as by deposition.* For this reason, *cæteris paribus*, large rivers are to be preferred to small.† Of this I am certain that water, taken either at Kew or Barnes at any time

* To the above reason for superiority may perhaps be added the fact mentioned by Mr. Walker in the Report to which I have already alluded—*viz*, the existence of springs in the bed of the stream;—there are strong grounds for believing that as low down as Battersea, springs of very great power and remarkable purity, enter the Thames at low water.

† I believe there is no doubt but that water taken at Henley, would, in time of flood, be cleansed by filtration with more difficulty than water taken at Kew or Battersea.

of tide, or at Battersea during ebb, and properly filtered, cannot be shewn either by sight, by taste, by smell, or by the most delicate analysis to be inferior in any respect—while in some respects it will be superior—to water taken at Henley, or Maple-Durham, or Oxford.

But if I am borne out in this conclusion, (and if the facts be as above stated, it seems to me difficult to arrive at any other) then to substitute for the present supply of Thames water, a supply taken from Henley or elsewhere, at vast cost, at great injury to private property, and at certain and serious hindrance of the navigation—would seem to be a wholly uncalled-for expenditure of capital.

It will be observed that I have said nothing of the supply given by the Lambeth Company. They draw their water from the Thames, between Hungerford and Waterloo bridges,—a site decidedly objectionable, and which it is necessary to change. I make this statement with the less hesitation, as they have already obtained (in 1848) an Act, enabling them to draw their supply from Thames Ditton, a perfectly unobjectionable source.

But it may be asked, are there no sources of supply available for London, better even than the Lea, the New River, or the Thames? I am aware of none, certainly none such have been brought before the public. The three sources, independently of the Thames, from which it has been proposed to supply the Metropolis, are, Artesian

Wells—to be sunk in London itself—springs in the neighbourhood of Watford,—and the Wandle.*

The Artesian Well scheme may be disposed of at once—the objections on more than one ground being insuperable. There is not the slightest ground, whether from reasoning or experience, for assuming that a sufficient, or even a small portion of a sufficient supply for the Metropolis could be obtained from this source. On the scientific branch of the question, the high authority of the Dean of Westminster, may be considered conclusive, while the accumulated proofs from experience are equally so. There are not a few deep spring wells in London—I doubt whether an instance can be found, in which difficulty has not of late years been experienced in procuring water, or in which the sinking of a new well has not been at once and very sensibly felt; what would be the result of attempting to draw from a hundred new wells 50,000,000 of gallons of water per diem?† But, if even an abundant

* An internecine war is at present raging among the advocates of the several schemes. The originators of the Henley plan, speak of the Artesian Wells as an impracticable scheme, while their own plan again is treated of in terms of much disparagement by the Maple-Durham projectors, and all are slightly esteemed by the advocates of the “Bushy meadows’” scheme. It may be observed, I think, that each party is more successful in attack, than in defence.

† I give, out of many that I might cite, one instance of the (so called) Artesian system. The Reform Club in Pall Mall, is

supply could be obtained, it is more than doubtful whether it would be worth having. I believe there are cases (at the North Western Railway Station, for instance) where, after such a supply had been obtained, it was found inexpedient to make use of it, and the analysis (No. V.) in the Appendix, will shew its exceeding inferiority to the water now supplied to London, as respects its saline ingredients. If to the two foregoing objections, either of which must be considered conclusive, be added the enormous outlay required—first, for procuring sites in London for 100 pumping establishments, and afterwards creating those establishments with their wells and engines on the requisite scale, and then the annual expense of such establishments, and of raising the water required for London, from the vast depth to which it would be necessary to go—the only surprise would seem to be, that any persons conversant with the subject should have been so long supplied by a well. Cost of well and 4 horse engine £1230. Annual expense £170.

The well is 360 feet deep, bottom of suction 85 or 90, water raised per hour 1500 gallons. If at the Trafalgar Square pumping establishment, they are only working by day, the engineer, beginning at eight in the morning, can pump on for 7 or 8 hours, until all the cisterns in the building are filled; but if the engines in Trafalgar Square have been at work during the night, he can only pump for two hours, and is then obliged to wait the greater part of the day before he can fill all the cisterns, at even the low rate I have mentioned, *viz.* 1500 gallons per hour.

with the subject should have thought the scheme worthy of serious consideration.

There remain only to be noticed as sources of supply, the Wandle and the Colne. In 1834, the late Mr. Telford, was directed by the Lords Commissioners of the Treasury, to report "on the means of supplying the Metropolis with pure water"—and having first expressed the opinion, that the supplies given by the New River and the East London Companies needed no improvement—(he did not even suggest filtration)—he recommended that the River Verulam, near Watford, and the Wandle, near Croydon, should be adopted as sources of supply. The expense of bringing the Verulam to Primrose Hill he estimated at £785,965 and the Wandle to Clapham Common, £391,875—together in round numbers £1,200,000.

For this sum he states that 7,000,000 gallons per diem can be delivered at Clapham at 82 feet, and 15,000,000 at Primrose Hill, at 146 feet above high water in the Thames. But without going into any examination of the sufficiency of his estimates for construction of works, and compensation to millowners* and others, or the practical difficulties of carrying his plans into execution; the scheme is open to the following objections:

* He admitted, on cross-examination before a Committee of the House of Commons, that he had totally omitted all compensation for the water used either for irrigation or for ornamental purposes, which his scheme would abstract.

1st. That the quantity of water is insufficient. The quantity to be brought to the south side of the Thames, being less than the quantity now supplied to that part of the Metropolis, and that to the north, but little beyond the present daily supply.

2ndly. That the elevation would not be sufficient to save pumping, and that there is no provision for filtration.

Supposing, however, that these difficulties could be surmounted, there would still remain the conclusive objection, that the water from either stream, when obtained would, as being decidedly harder, be inferior in quality to the water of the Thames. This might have been expected, as both those rivers rise in chalk strata; but it is shewn conclusively by the analysis (No. III. in the Appendix) of Dr. Bostock, employed (by Mr. Mills, Mr. Telford's assistant) with a view to the scheme in question. I have not myself the shadow of a doubt, but that if the water of the Wandle or the Colne could be substituted for that of the Thames, as a supply to London, the public, before a month was over, would regret the change.*

* For the half of the year during which I reside in the country, I use the water of the Colne, and for the other half that of the Thames, and can speak from personal observation as to the respective qualities of the waters of the two streams. As to the greater softness of Thames water it may be a homely, and not a very scientific illustration, but yet one that will come home to the feelings of my male readers at least—*razors*—require setting much oftener with Colne than with Thames

And here it may not be out of place to remark on Dr. Clarke's plan for softening water, to which I observe that reference has been made in some of the new schemes of supply. It consists in precipitating the carbonate of lime, held in chemical combination, by the admixture of a certain quantity of water saturated with lime deprived by calcining of carbonic acid. The discovery is ingenious, the mode cheap and simple, and one that might be resorted to with advantage in private families for all purposes for which perfectly soft water is required. But, in the first place, I doubt whether it would be acceptable to the consumers to have no other water than such as had been so treated; and, in the next, the practical difficulty of thus dealing with the daily supply required for London (equal to the whole contents of the Serpentine river) would be found all but insuperable. Of course, if it were desirable, it could be done by the present Companies, who possess all the necessary means and appliances, in reservoirs, engines, &c. but I repeat, I do not believe it would be either practicable or desirable.

I have not especially adverted to the "Bushy Meadows Wells" scheme, as the quality of the water. I may add that when the Grand Junction Company changed their source of supply from the Canal to the Thames, one of the motives for the change was, that the hardness of the water of the Canal (supplied almost wholly from the Colne) was complained of.

water would be the same as from the Verulam, and this plan, in addition to the objections which exist to making use of that stream, would I apprehend be subject to some added difficulties of detail, and also to some doubts as to the sufficiency of the quantity to be obtained.

I have now gone through in sufficient detail, and certainly with the intention at least of fairness, the main facts and considerations bearing on the quality of the present water supply to the Metropolis, and the possibility of improving it, and they seem to me, I confess, to lead to the conclusion, that the only improvements required are :

X 1st. That the water should be filtered prior to delivery ; and,

2ndly. That when taken from the Thames, within the tidal range, it should be taken with such precautions as would ensure its being unaffected by the London drainage. I am quite aware that the very simplicity and comparatively trifling nature of these improvements, and the facility with which they may be carried into effect, are in the present excited state of the public mind, likely to prove an objection to,—rather than any recommendation of—my suggestion ; but I have a strong persuasion, that full investigation and calmer reflection will shew that they are all that are necessary.

If, however, I should be mistaken in this opinion, if I should have inaccurately informed myself of facts, or taken a wrong view of the inference to be

drawn from them, if it should indeed be true that wholly new supplies of water are required, then I admit without a moment's hesitation that they ought to be obtained. Through what agency, and on what conditions they should be obtained, will form the subject of another chapter.

CHAPTER IV.

MODE OF SUPPLY, "CONTINUOUS," AND "INTERMITTENT."

THE above appellations now commonly used to designate the two different methods of supplying water, have led, I suspect, to considerable public misapprehension, as to the character and merits of the two systems. They describe with sufficient accuracy the respective modes of supply—they do not convey an equally just impression as to the power of using water conferred by the systems respectively on the consumers.

To judge from the language held for the last few months, the prevalent belief would seem to be—

1st. That by the "continuous" supply system, the public—the consumers of water—have it always at command, while by the "intermittent" system they are frequently without.

2ndly. That by the former, they have a more abundant supply than by the latter mode ; and,

3rdly. That while, in consequence, it is for the interest of the public to have the "continuous," it is for the interest of the suppliers of water, the Water Companies, to give an "intermittent" supply.

Now these conclusions, acquiesced in probably by ninety-nine persons out of a hundred, who have

not paid attention to the subject, not only express inaccurately the real state of the case, but are in various essential particulars, absolutely opposed to the truth. That the quantity of water furnished under the 'continuous,' is greatly less than under the 'intermittent' system, is sufficiently manifest from the facts already adduced, while the examination on which we are about to enter, will shew as clearly, that while under the 'continuous' system, as at first explained and acted upon, failure of supply, from circumstances, of possible, indeed not unfrequent occurrence must occasionally happen, under the intermittent system, such interruption cannot occur, except from a want of the commonest attention on the part of the recipients of the supply.

On the comparative merits of the two systems, nevertheless, I entertain no doubt. I am satisfied of the great superiority of the 'continuous' system (with some modifications to which I shall presently advert), as applicable to new localities. I am perfectly satisfied even of the desirableness of adopting it in London,—but that there will be considerable difficulties in so doing,—and difficulties of a kind not commonly anticipated, inasmuch as they will arise not with the Companies, but the public,—I am equally certain.*

* It is but of little importance to the reader, but I may state that I have, within the few last years, considerably changed my opinion as to the application of the 'continuous' system to London. I am more favourable now than formerly to such an

The respective systems may be thus described :

The 'continuous' system requires the water to be always "on," in Waterworks' language ; that is, there should always be a sufficient head or strength of water in the mains to enable it to reach the highest level in every house in the district supplied. No provision of water, it is said, being thus required,*—a cock on the service-pipe being all the apparatus necessary,—the expense of cisterns will be spared, and the quality of the water will be better than if it be retained in receptacles within the house.

The 'intermittent' system, on the other hand, requires that in each house there should be sufficient cistern-room to keep water for the use of the occupants during the intervals between the periods when the water is "on."

experiment. The objections to the system, as at first explained and acted on, strike me with the same force ; but recent experience has shewn the waste in London under the present (the intermittent) system, to be so enormous, and the facility of supplying the dwellings of the poor under the continuous system to be so much greater, that I am strongly of opinion an attempt should be made to obviate those objections.

* For the degree in which the dispensing with tanks, cisterns, butts, or receptacles of any kind, for retaining a provision of water, is considered a valuable as well as an essential part of the "continuous" system, see the Evidence of Mr. Thom, Mr. Anderton, and Mr. Hawkesley, the engineers of the Glasgow, Preston, and Nottingham Waterworks, appended to the first report of the "Health of Towns' Commissioners."

In comparing the above processes, the first point worthy of observation is the greater economy of the former. The annual expense of supplying a given district with water, under the 'continuous,' would no doubt be considerably less than by the 'intermittent' process. This will be obvious on a moment's consideration. Under the former there will be no waste of water, or next to none. Persons might, no doubt,—supposing that there were sinks and drains under the water-cocks,—from mere wantonness, let the water run to waste,—but this would require an act of volition,—something to be done,—which all experience shews will prevent its being a common occurrence—while under the 'intermittent' system, mere neglect will answer the purpose; it is only omitting to keep the ball-cock, which stops the influx of water when the cistern is full, in order, and the water overflows down the waste pipe as long as the head is kept up in the main in the street. There is also the temptation of a saving,—paltry, it is true, but yet enough to operate on many minds,—in dispensing with a ball-cock altogether.

In works, therefore, constructed on the 'continuous' system, there will be a saving in the expense of procuring the supply,—a heavy item, of course, when the water has to be pumped, as is usually the case, and filtered. There will also be some saving in the distribution. Under the 'intermittent' (the present metropolitan system), a Water Company's

district is subdivided into Turncock's districts, the water being turned on to each in succession. Of course, if the water be always on throughout the whole district, there would be much less occasion for such functionaries or their assistants.

With regard to the original cost of works, on one or the other principle, I am disposed to think there would be no great difference; but it would be unnecessary for my present purpose to trouble the reader with any discussion on this part of the question.

But this advantage of economy in furnishing the supply, and the saving to the consumers by dispensing with cisterns, are counterbalanced by objections of no little weight. What is the condition of a house supplied on the 'continuous' system, and without cisterns? There must be a pipe connected with the main, rising to the top of the house, and with a cock or tap on each floor. I believe it to be quite certain, that from such a pipe water could not be simultaneously drawn on all the floors from the bottom to the top of a high house, of such houses, for instance, as those in the new parts of London, all of five, and most of six stories.* This objection would be felt to be con-

* The difficulty might probably be got over, by greatly increasing the size of the service pipe, and also of the supplying main, but in the first place the result of the expedient might not be quite certain, — and, in the next, the expense would be little inferior, perhaps equal to that of furnishing cisterns to each house.

siderable by persons accustomed to an unlimited command of water, at any moment, in any part of their houses, but one of greater force remains. I am aware of no means by which the supply from the main can be rendered at all times, and under all circumstances, free from interruption. This interruption may arise from some defect in any one service pipe, from taking a fresh tenant on the main, from accident to the main itself, or the necessity for public convenience, to make some alteration in its level or direction (in all which cases the main must be emptied), or from frost.*

From some of these various causes, but more especially from the latter, the freezing of the service pipes, —suspension of supply from the main is, a thing not only of possible or probable, but from time to time of certain occurrence. But what, under such circumstances, would be the condition of a house without cisterns? one of exceeding discomfort certainly; scarcely safe, perhaps, for the large reservoirs which it is now the practice

* It is not unimportant to observe, that interruption of supply from this latter cause, must of necessity be of much more frequent occurrence, under the 'continuous' than the 'intermittent' system, as, under the former, the service-pipes are always charged, and will then of course freeze, unless great care be taken,—under the latter, the service-pipes may be laid so as to empty themselves back into the main, the moment the head is off; there is then no risk of their freezing, as there is never water in the pipe, except when it is flowing through it with a rapid stream.

to attach to kitchen-ranges, are not without risk, unless kept full of water.*

The truth is, that the experience of the "continuous" system is as yet incomplete. It has been adopted in towns which had previously either very imperfect water supplies, or none—and the inhabitants of which had experience of no other mode, with which to contrast the supply they now receive. In such towns, the being occasionally without water, would scarcely be felt to be an inconvenience, and it has accordingly been customary, I believe, when any circumstance renders it necessary, to take the head of water off the main in the street, to send notice to the tenants, and they provide themselves as well as they can, as long as the suspension of supply continues.

The foregoing objections are so formidable, that if they could not be obviated, they would, in my apprehension, leave exceedingly doubtful the comparative merits of the two systems, even as applying to new localities, but I do not believe such to be the case. The greater economy of the 'continuous' system and its undoubted advantages, as a mode of supplying the dwellings of the poor, will lead to its being widely adopted, and as experience will shew the extreme inconvenience of dispensing altogether with cisterns, some mode will be resorted to of rendering the use of them compatible with 'con-

* It may be added, that a cistern is essential to the construction of the most approved form of water-closet.

tinuous' supply. Such a modification of the system would, of course, deprive it of that recommendation, which, as I have said, has been much insisted on, viz., the saving in the construction of a house, by dispensing with cisterns; but this I hold to be a consideration of very inferior importance. Any unnecessary expenditure of money is of course to be deprecated; but the really important object is to secure the best possible supply of water to a dwelling—no outlay necessary to that end can be said to be superfluous.

Such a modification of the system, is in fact already taking place. It has not been found either convenient or necessary to dispense with cisterns, and accordingly the use of them is provided for in the more recent instances of the application of the system. From the regulations now lying before me, of several plans where that system has been adopted, I give an extract* from those in force at Coventry, which I have selected, because the works in that town were constructed by—or, are under the direction of Mr. Hawkesley, who has been the principal advocate of the new system.

Can the 'continuous' system be applied to London? Of the advantage of so applying it there can be no doubt—as little, I am afraid, of the difficulty. But that difficulty, it should be clearly understood, would not arise with the Companies. Let them have the same protection as is given in the

* Appendix, No. 6.

case of the Coventry Water Works—and as they have certainly the means, so there can be no doubt, they would have the inclination to carry the continuous supply system into effect in the Metropolis. But will their tenants—will the consumers of water be equally ready to make the change, when they fully understand all the bearings of the question, and the restrictions to which they must submit? For restrictions there must be. To apply the continuous system to London, with the existing arrangements for the use of water in the interior of houses, would be impossible—and useless were it not impossible. No conceivable increase to the quantity of water now given, would keep up a constant supply, and as the quantity is even now more than abundant, the whole increase would be given in waste.

But for the clearer understanding of the question, and the better apprehending what would be necessary to render the application of the continuous system possible—it would be convenient, perhaps, that I should briefly describe the present mode of supply.

We will take one district as an instance, and we will select the Grand Junction district, both because it comprehends some of the most important of the old as well as the newer portions of the Metropolis, and because there are considerable differences of level.

It extends from Pall Mall on the south to Pad-

dington, on the north, the difference of level being not less than 100 feet, the tops of the houses in Pall Mall being from 50 to 70, and of those in Hyde Park Gardens, from 150 to 170 feet above the level of the Thames, (Trinity standard). It is subdivided into nine turncocks'* districts, and is on the present system perfectly supplied. The whole force or head of water is given in succession to the different levels, the lowest first, until at length the head being left to operate solely on the highest, the water is forced into the topmost cisterns of the houses in the most elevated parts of the district. Would the upper stories of houses so placed be served efficiently, if all the mains throughout the district were opened for supply at the same moment, it being borne in mind that the hotels, the club-houses, and the larger private dwellings are chiefly situated in the three lower districts? I assert without fear of contradiction, that no Waterworks' engineer, no man in the slightest degree conversant with practical hydraulics, would say that the supply of water to the higher levels, (the upper stories of the houses in Hyde Park Gardens for instance), could be depended on, whatever were the amount of water pumped into the district.

There cannot be less than from 30 to 40,000

* Viz. The St. James's Square, Golden Square, Berkeley Square, Hanover Square, Grosvenor Square, Connaught Square, Gloucester Square, Westbourne and Kensington districts.

cisterns in the Grand Junction district.* Some of the larger private houses, and more especially the clubs, have from 10 to 15 cisterns each, all furnished with waste pipes, and those waste pipes discharging themselves unseen into the drains. The waste of water thus occasioned is even at present very large, but it has a limit, each turncock's district is supplied in an hour or an hour and a half, then the head of water being taken off, the waste ceases. What would be the result if the head were on throughout the district for the whole 24 hours? Why beyond all doubt that a continuous supply would be impossible.

Supposing it then to be desirable to adopt the continuous system, to what means must we resort to render its application possible? The dispensing with cisterns is not to be thought of. I am satisfied that the inhabitants of the metropolis, accustomed to the unlimited supply of water always at command in every part of the house, would not submit to any mere limited use of it, still less would they submit to the total interruption of supply, which in such case would arise from accident to the main, or some other of the causes to which I have referred.†

* I have no means of knowing the precise number, which could only be accurately ascertained by inspection of every house, but the opinion of the officers of the Company is, that it cannot be below what is stated in the text.

† In the Appendix will be found an abstract of the work absolutely done in one year in the Grand Junction district, which

Cisterns then must of necessity be permitted, whether fully to the present extent, may be doubted—but as an absolute condition (for it is clearly the *sine quâ non*—of resorting to the continuous system), all waste or overflow pipes must be prohibited. Nor do I know that this should be considered as a valid objection to the change. The use of a waste pipe is to guard against the injury occasioned by an overflow of the cistern; but this overflow can only arise from the ball-cock in the cistern not acting, and it is perhaps not too much to expect from the occupants of houses, that they should exercise the very easy vigilance necessary to ensure the ball-cock being in order. But it will also be necessary that on the part of the Companies, a much stricter supervision should be practised, than the inhabitants have heretofore been accustomed to. What the nature of that supervision must be, may be gathered from the Coventry regulations,—it may be added, that as in London, from the great size of the houses, and their present arrangements for the use of water, the facilities of waste will be far greater than in any town to which the continuous system has yet would, under the continuous system, have occasioned an interruption of supply to the tenants in some portions of the district. It will be observed, that there was no interruption from frost, or from alterations in the levels of streets, &c. It is possible, no doubt, that precautions might be taken which would diminish the number of interruptions, but I do not believe their recurrence could be entirely obviated. In a house well furnished with cisterns interruptions of supply are not felt.

been applied, so must the water police (if I may use the term), be more vigilant and inquisitorial, and the regulations against waste be more rigidly enforced. These conditions, however, being complied with, there cannot be a doubt of the Companies being enabled to give the continuous supply. I will answer for those with which I am connected. There might be somewhat greater difficulty in London than has been experienced elsewhere, from the fact that some of the largest consumers, the Clubs and Hotels for instance, in one portion of London, and the various manufacturers in others, expend the greater part of the supply they receive in comparatively a small portion of the twenty-four hours, but this difficulty could be surmounted by a different arrangement of mains, and I repeat, that the Grand Junction, and the Southwark and Vauxhall Companies (and for the same reasons by which they would be influenced, I cannot doubt, the other Metropolitan Companies likewise), would willingly substitute the 'continuous' for the 'intermittent' supply. The question, however, is one not for the Companies, but for their tenants to decide.

There has been an impression that water is injured by being retained in cisterns, but I believe the opinion to be without foundation. It can have arisen only from the effect produced on water kept in cisterns outside the dwellings and uncovered. In such case, no doubt, the water will be injured—first, by that exposure to the sun and air, which

has a tendency in any water to generate both vegetable and animal life,—and secondly, by collecting the soot and filth from which the London atmosphere is never perfectly free. Thames water filtered, put into a clean cistern, inside a house, will remain for weeks or months with no other change than becoming even more perfectly bright from the repose, than when it first flowed in from the main; this quality, however, of the water can be but rarely, and need never be put to the test, as every house receives a fresh supply every day.*

By far the best argument, however, in favour of the 'continuous' system is to be found in its superiority to the rival system, as a means of supply to the dwellings of the poor. Of its great advantages in this respect there can be no doubt. It may be true that the cost of providing the butt or barrel, commonly used in such dwellings to hold a provision of water may be small, but it is rare that space for any receptacle of the kind can be found *within* such dwellings, and if placed outside (if

* I think I have somewhere seen it stated, as an objection to cisterns (lead cisterns at least), that they might be acted on by the water, which would then be injuriously affected. Any such supposition is wholly without foundation. Distilled water will act on lead, but no water containing the smallest portion of mineral salts. It is certain that no water supplied to London will act on lead. I am not quite sure that all the Companies give a daily supply. I am quite sure that all might do so with advantage,—where the practice has been adopted, it has not been found to lead to greater waste—than the giving a supply only on alternate days.

even there be a court or garden which will allow of its being so placed), there is almost the certainty of its being left uncovered and exposed of course to be injured by the action of the atmosphere, as well as polluted by soot and dirt. Again, in such case, the butt is on the level of the ground, and the great advantage of having the water without labour on the upper floor or floors of the house (a convenience yet more important to the poor than the rich), is consequently lost. It would be practicable however to give a continuous supply to certain portions of the town, without a general adoption of the system. In the Appendix will be found a report from Mr. Quick (engineer to the Southwark and Vauxhall Company, and consulting engineer of the Grand Junction Company), suggesting two or three modes, by any of which the object might be accomplished, and others probably might be devised.

It has been stated as one of the advantages of the continuous system, that it afforded a better supply for the extinction of fires,—but the fact is, that the mains throughout London, are always charged during the night, and how ample and un-failing in consequence is the supply afforded for that purpose, the reports made public from time to time, by the active and intelligent superintendent of the London Fire Brigade, Mr. Braidwood, abundantly testify. It has been supposed that on the continuous system the head of water always in the mains, would dispense with the necessity of using fire engines. I believe that well-founded doubts exist, whether this

would be practicable under all circumstances, That a jet of water direct from the main, might be occasionally used with great advantage is certain, and provision ought to be made for it; but at all events, there must be at least as great a facility in getting a strong head of water in mains which are *not*, as in those which *are* exposed to the constant abstraction of water for domestic use.

From what has been stated, my readers will be enabled to form their own judgment, as to the practicability or expediency of attempting to apply the continuous system to the Metropolis. If the administration of the supply be taken into the hands of some public authority, then there can be no doubt, I think, but that it would be desirable to make the alteration, but if it be still entrusted to the Companies, I am quite sure that to enable them to enforce the conditions which will alone render the application of that system possible, they will require not only the intervention of the Legislature, but the utmost amount of assistance they can receive from public opinion.

CHAPTER V

MONOPOLY AND COMPETITION.

THE question, whether the principle of competition can be applied with advantage to the supply of water, has been so repeatedly subjected to the test both of argument and experience, and invariably with the same result, that it might seem superfluous to trespass even for a moment on the attention of my readers by the discussion of an exhausted subject, but when it is borne in mind that not longer ago than last Session, a bill was introduced for the supply of the Metropolis on this principle, and that not only the same bill, though then defeated by a large majority, is to be again brought forward but that no less than six others, for a like purpose, are to be submitted to Parliament,* I may be pardoned for referring briefly to the opinions on this matter of judges, alike competent

* Most, if not all, I believe seek for powers, in default of being able to induce the present Companies to take the water they propose bringing, to lay down pipes, and distribute it themselves.

and disinterested, and pointing out the striking illustration which the history of the water supply of London affords of the soundness of those opinions.

“Competition,” says the Report of a Committee of the House of Commons, which sat in 1821, “in ordinary cases, adjusts the supply to the demand, through the liberty which the sellers have to go out of the market as well as to come into it; but in trades carried on by means of large capitals vested in fixed machinery and furnishing a commodity of no value but for consumption on the spot, the sellers are confined to the market by the nature of the trade; and if the new comer has to seek immediate employment for large works, by taking custom from the established dealer, as there can be no great difference in the quality of what they sell—they must vie in lowness of price, and will probably be driven to underbid each other down to the point of ruin, because it is better to take any thing than to take nothing, for that which cannot be carried away; and this must go on until both are worn out, or one has outlasted the others, and succeeded to a real and effective monopoly—or until by some arrangement between themselves they can put a stop to their mutual destruction.”

Clearly as the foregoing considerations are stated, they are yet so obvious, that one is lost in astonishment, at finding that they should, at any time, have been wholly overlooked in legislating on this matter. Yet that such is the fact, is clearly shewn by the record of the dealings of Parliament with the question.

In the early part of the present century, the Metropolis north of the Thames, had already outgrown the means of supply in possession of the Companies then in existence, the London Bridge,

the New River, the York Buildings, and the Chelsea,* and three new associations having been formed to supply the deficiency, applied to Parliament for Charters of Incorporation. What was the course taken by the Legislature? why to omit every thing that it would have been wise to do, and to do precisely that which ought not to have been done. Not only was no attempt made (for which the opportunity was peculiarly favourable), to compensate the old companies and place the whole supply of the Metropolis under some municipal authority, but no limitation was placed on rates, no stipulation made as to the quality of the water to be supplied. On the other hand every Company, the new as well as the old, had a roving commission to supply all or any part of London, and if at this moment we have not six sets of mains in every street, and every thoroughfare rendered impassable by an incessant change of tenants, from competition between the Companies, or the public be not paying treble the present rates, as the necessary consequence of their coalition,—if from these inconveniences and absurdities we be now exempt, assuredly it is not to the wisdom of Parliament, that we owe the exemption.

* There were also, as I have already mentioned, two small companies in the East of London, the Shadwell and the West-Ham, whose works, first purchased by the London Dock Company, in 1807, were repurchased by one of the new Companies, the East London, established in that year.

The new Companies having obtained their Acts of incorporation were not slow in entering upon the career of folly and ruin opened to them by the Legislature. They ran their mains into the districts alike of the old Companies and of each other, engaging in all directions in a competition so keen, that occasionally the rival gangs of pipe-layers had pitched battles in the trenches. They sent round to every house statements and counter-statements, they opened rival jets from their mains to show the better quality of the water they respectively supplied, or the greater height to which it could be thrown, and they underbid each other, or abstained from asking for payment until only some few persons with tender consciences thought it necessary to pay any rates at all, it being quite easy of course to change to the rival Company a few days before the time when the collector of the Company by which the supply had been given, called for payment.

This absurd contest lasted until the Companies, weary of mutual destruction (for it is scarcely necessary to say, that none got any return whatsoever on their capitals), agreed first to a cessation of hostilities, and then to an arrangement by which they severally withdrew their mains into the districts they now occupy. It will probably be thought that they did not come to this understanding without justification, when it is known what the results of the struggle had been.

The York Buildings Company was ruined, and dissolved.

The East London established in 1807 —

Paid in	1810	. . .	4 per cent	} no doubt out } of capital.
	1811	. . .	5 „	
	1812	. . .	2 „	
	1813	}	none	
	1814			

The New River Company is divided into 72 shares, on each of which the capital expended, was in 1828 £14,400. The average dividend for 10 years from 1800, was £455, per annum, for 10 years from 1810, £173 per annum, and during the years 1813, 14, 15, and 16, respectively, £125, £25, £63, and £85.

The West Middlesex Company, established in 1807, was for 12 years, namely, to 1819, without any dividend at all.

The Grand Junction Company, established in 1809, was for 10 years to 1819, equally without dividend.

The Chelsea Company did not diminish their dividend, but they were only paying altogether £2,400. per annum to their proprietors. During the century that had elapsed from their foundation to 1820, they had been 30 years without any dividend.

After the arrangement, four of the Companies, the Chelsea, the Grand Junction, the West Middlesex, and the East London, raised their rates 25 per cent above the scale which existed before the com-

petition began in 1810, nor can that rise be justly said to have been in itself unreasonable—first because a large increase of outlay had been incurred by that very competition in which Parliament itself had encouraged them to engage, and secondly, and for a better reason, because they gave a far better supply than had been given in 1810. The report of the Committee states that the supply to the consumers was given with greater certainty and regularity, and had increased in quantity in the ratio of 5 to 4, but this was much below the fact.

Such however was not the feeling of the public, indignant, and to a certain degree, justly indignant at having been misled, although their indignation should rather have been directed against the Houses of Lords and Commons, than against the Companies. Meetings were held, and petitions were presented to Parliament, complaining that Companies established on the principle of competition had coalesced and created a monopoly, complaining likewise of the increased charge, and praying for redress. These petitions were referred to a Select Committee, which after a protracted inquiry, and the examination of many witnesses, agreed to the report from which I have given an extract. The Committee admitted that the arrangements between the Companies “so questionable at first sight, and carrying with them so much the appearance of a combination against the public, were nevertheless measures of self-preservation.” They did not consider the advance of

rate unwarranted by the circumstances, but they recommended that a bill should be brought in limiting the Companies to the rates then charged, and suggesting various useful provisions for the protection of the public. No such bill however was brought in, either then or at any subsequent period, and the interference of the Legislature on behalf of the public, with the supply of water to the Metropolis, has been limited to the insertion of some few provisions in the bills, which for purposes connected with their own internal arrangements, the Companies have from time to time brought into Parliament. These provisions have consisted mainly of the insertion of a scale of rates,* and of clauses requiring the depuration of the water by deposit or filtration.

I have hitherto spoken only of the proceedings of the Companies north of the Thames, but the same series of circumstances ending in a like result, occurred at a somewhat later period on the south of the Thames,—competition between Companies encouraged by Parliament—mutual injury, and final arrangement, with a restoration of rates to the same level, in some instances a higher level, than that from which they had fallen. The history of this struggle, as given in a memorial to the Sanitary Commissioners, from two of the South Metropolitan Companies, referred to by the Commissioners in

* The scale is the same as has been for some years inserted in all Water Works bills. The Metropolitan Companies so limited in charge are—the East London, the Grand Junction, the Southwark and Vauxhall, and the Lambeth.

their report, and contained in the Appendix, may be worth adverting to.

“The Companies,” say the memorialists, “by which that portion of the metropolis is supplied (the Southwark, the Vauxhall, and the Lambeth Water Companies) were, from the periods of their being respectively established, and prior to 1834, in possession of Charters, which more or less permitted or encouraged competition; but in that year, having all had occasion to apply to the Legislature for further powers to raise capital, certain restrictions, which tended in some cases to preserve the several Companies’ districts free from the operations of the others, were removed, and from that period a competition, in which sometimes two, sometimes all three were engaged, has ensued, which was in full activity during the years 1839, 1840, and 1841, and which has only completely ceased since 1842. The results of that competition were as inconvenient to the public as disastrous to the Companies, and afforded the very strongest illustration of the truth of the doctrine laid down by the Committee of the House of Commons in 1821, that the principle of competition cannot with advantage be applied to the operations of Water Companies.

“As regards the Companies, the result of the struggle was an immense expenditure of capital in utter waste—double and treble sets of mains and pipes being laid down in districts, where one set would better have served the inhabitants. An enormous annual outlay, equally in utter waste, in the salaries of canvassers and commission to agents who procured tenants—in the bills of plumbers who changed the service-pipes of the tenants from one set of mains to another—in the charges of taking up and relaying roads and pavements on the like occasions—in double and treble sets of turncocks and pipe-layers, and, as the climax of absurdity, a payment of all parochial and district rates in every parish on all the pipes of all the Companies in proportion to the capital expended, on assumed profits or interest, which it is needless to say had no existence. These expenses being accompanied by a great reduction of rates, the result was such as might have been anticipated; one of the Companies,

overwhelmed with difficulties and debt, ceased to pay dividends to its shareholders, the other two must shortly have arrived at the same condition, and the total return on more than half a million of capital expended has not since been, and is not now, more than £2 $\frac{3}{8}$ per cent per annum.

“The inconvenience, as regards the public, was scarcely less striking. The funds which should have been devoted to improving the supply of water were wasted; the districts which, being densely peopled, were supposed likely to yield a return, were encumbered with double and treble sets of pipes, and disturbed by the daily breaking up of the streets and roads, consequent on the incessant change of tenants from one Company's mains to those of another; while other districts less thickly inhabited were left without the supply necessary for domestic convenience, or protection from fire. The impoverishment of the Companies, arising from the double source of unnecessary expenditure and uncalled-for reduction of rates, tended to incapacitate them from adequately discharging their duties to the public, and left them neither means, leisure, nor inclination for improving to the utmost the supply of water given to their tenants. Independently of the wasted capital in superfluous mains and pipes, the sum as above stated annually thrown away in plumbing, paving, and canvassing, was more than adequate to the depuration by deposit and filtration of the supply to all the tenants of the three Companies. Neither was the sole end, which it might perhaps be supposed competition would answer, permanently attained. The prospect of impending ruin compelled a suspension of hostilities, and the rates of the whole district were raised to a level, which, though still very low as compared with the rest of London, are yet at least as high as would have obtained had there been no competition.”

Subsequently to the date of this memorial, the Southwark and Vauxhall Companies applied for and obtained an Act uniting them into one Company. By the united Company great improvements

have been made in the quality and mode of supply, and in the large district it serves, the superfluous mains and pipes have of course been taken up ; but with the Lambeth Company an arrangement only as to price has been entered into, and there are consequently, in the southern half of the Metropolis, at least 100 miles of streets and roads in which there are double sets of mains, with all the absurd consequences of wasted capital, double rates, &c. &c., referred to in the foregoing extract.

When such are the inconveniences, and such the fruitlessness of a system (if such it can be called) of competition, it is not surprising that every witness examined on the subject of water supply by the Sanitary Commissioners should have joined in condemning it, or that the Commissioners themselves should expressly recommend that it should nowhere be permitted. If, in opposition to their deliberately expressed opinion, it were possible to suppose that Parliament would again commit the grave error (an error less excusable after than before half a century's experience) of sanctioning the establishment of rival Water Companies for the supply of the Metropolis, there cannot be a doubt but that the scenes I have described would be acted over again. If, for instance, the Henley scheme were to receive the sanction of the Legislature, as it is certain that the existing Companies would not pay for a supply of water nowise superior to that which they had already laid out large sums to obtain for themselves, the new adventurers must, to obtain

any return on their capital, proceed to lay down mains in the streets of London for the distribution of the water they had brought to its vicinity.* Every street, therefore, in the Metropolis would first be cut by a deep longitudinal trench for the reception of the mains, and then transversely, from day to day, as long as the competition lasted, for the purpose of transferring the service-pipes of the tenants from and to the respective mains of the rival Companies.

It is scarcely necessary to inquire whether such a condition of thoroughfares, already insufficient for the traffic flowing through them, would be tolerable; and what, meanwhile, would be the result of the struggle on the Companies themselves? As the quality of the respective supplies would be equal,† the competition would be only in price.

* One of the first Companies with which they would come into competition would be the Grand Junction. In the district of that Company the London portion of the important parish of St. George, Hanover Square, is comprised. During the late epidemic, the parish authorities sent round officers, called "inspectors of nuisances," to inquire into the sanitary condition of the population. I believe I am right in saying that in no instance was any complaint made of the quantity or quality of the water supplied.

† It may seem strange, but it is nevertheless true, that in a competition between Water Companies, quality has scarcely any effect. Unvarying experience has shewn that cheapness is the only effectual weapon. The great majority of consumers being even willing to take the worst water in preference to the best, if offered at a lower rate. In the case supposed, however, there would be no difference of quality.

The old Companies would of course reduce their rates to a scale equal to or below that at which the new Company would offer a supply ; and this contest would go on until neither one nor the other would obtain a sixpence of return on their capitals. Of course also this would end in a compromise, and after a period of almost insufferable annoyance to the public, as well as to the competing parties, the rates would be raised again to the same level from which they had fallen, or probably to a higher, as there would then be two capitals instead of one on which interest must be paid.

Must the supply of water then, it may be asked, be of necessity a monopoly, and are there no means by which the public can be protected against the evils which monopoly is sure to engender? I answer without hesitation, that as it is absolutely demonstrable that you cannot have competition, you must of necessity have monopoly, inasmuch at least, as employing only one capital to discharge functions for which one only is required, deserves that term. It remains only to decide in what hands that monopoly shall be vested, or to what control and limitations it shall be subjected. There is no doubt, I think, that it should be, wherever practicable, vested in the hands, not of individuals but of some authorities, municipal or other, acting on behalf of the public. For thus vesting it, there are reasons which seem to me conclusive :—

1st. A supply of water, abundant and of good

quality, is so absolutely essential, not only to the public health, but even to public morals, that it would appear on this account alone, to fall within that class of functions which a Government is bound to take upon itself.

2ndly. There is great and obvious convenience in the supply of water being vested in the same authority in any locality as the paving and sewerage.

3rdly. There is, perhaps, no other mode by which the public can be perfectly protected against the possible occurrence of some of those evils to which monopoly has been found to lead, and at all events, the cost of water will, or ought to be less to the consumer. To private parties the supply of water is a commercial enterprise—they have a right to look for rates which will not only pay current interest on the capital expended, but as much larger a return as will be a compensation for the risk incurred. This right is founded in justice, and must always be, as it has always been, recognized by the Legislature.

4thly. There is nothing in the character of a water supply, which places it beyond the range of those functions which public authorities may conveniently discharge. There is no commercial acuteness required, no buying and selling, no watching of markets. The works once well formed—the carrying them on may be entrusted, not only without inconvenience, but perhaps with advantage to one superintending officer, acting under the control of the governing authority.

Lastly. The parties distributing water must of necessity be invested with very stringent powers, partaking of the nature of the powers of a police, which will of course be less invidiously, as well as more efficiently exercised by the recognized agents of public authority, than by the servants of a company.

If such an arrangement as the foregoing be impracticable, and the supply of water be left in the hands of individuals, then it should be subjected to careful regulation—and while the fair rights and interests of those by whom it is furnished are protected, every arrangement should be stipulated for—which the public health or convenience may require. What should be the nature of these regulations in the case of the Metropolis, as well as the mode by which the better system to which I have adverted might be adopted—I propose to consider in the next and concluding portion of these remarks.

CHAPTER VI.

IMPROVEMENTS REQUIRED.

THE first reform I am disposed to suggest, relates to the agency through which the supply of water to the Metropolis is administered. In conformity with the opinion expressed in the foregoing chapter, I think it would be desirable to transfer the duty of furnishing London with water from the Companies to some public authority. Some such authority, I presume, will be created by Parliament for the discharge of various functions connected with the sanitary condition of the Metropolis, and to that body the administration of the supply of water should also be confided.* For this purpose, the authority so to be created, should be empowered to purchase the works of the existing Companies, and for the completion of such an arrangement there exist great facilities.

* This is not an opinion recently taken up. Several years since I suggested a scheme of this kind, in quarters where I knew it would receive careful consideration. I need hardly add, that by the authority referred to in the text, I mean something very different from the "Water Association," to be constituted of parochial deputations, which of all conceivable modes of dealing with the question, would assuredly be the worst.

That the Companies are entitled to expect—as in all cases where the property of individuals is taken for the public convenience—that the terms to which they are required to submit, should not only be just, but liberal, I need hardly say. From what has been already stated, it will be sufficiently clear, that the Companies have been guilty of no malversation of the powers entrusted to them by the Legislature; but they may justly claim a higher praise—I assert, without fear of contradiction, not only that they have fulfilled, but that they have more than fulfilled all the obligations imposed on them by Parliament; that while they have conferred great benefits on the public, they have, under circumstances of no inconsiderable temptation, abstained from exacting that return which they were legally entitled to demand, and which, the analogy of capital similarly invested, might have justified them in expecting.

The truth is, that all that has been done wrong in this matter has been done by the Legislature—all that is right by the Companies themselves. They have laid out on their works, with the sole view of improving the quality of their supplies, large sums which they were not required by their acts of incorporation to expend, whilst on the other hand they have been contented with very much lower rates than by law they could have demanded. Such of them as have a Parliamentary scale of rates, not only have not exceeded it, but the cases I believe to be exceedingly rare in which that scale has even

been approached. When in 1819, on the completion of the arrangement by which the Companies did for themselves that which Parliament should have done for them, viz. confine their services respectively to separate districts of the Metropolis, they limited themselves to an advance of rates, the moderation of which, under all the circumstances, cannot be denied. They were Corporations in perpetuity, and had at that moment—even less than the Railroad Companies have now—reason to fear the establishment of rival Companies—for the public had become thoroughly disabused as to the profits of Water Companies, and their shares were all but unsaleable. They had been for years without dividends—they were unlimited in their rates, and yet the prices they charged for water, when their monopoly, as it has been called, was secured, did not yield an interest of less than 4 per cent. on the aggregate capital expended.

That they have since prospered has arisen from the wonderful increase of the Metropolis,—an increase which at that time could not have been anticipated. That increase was profitable to them, as it augmented their revenues without a proportionate increase of annual expenditure, but of the increased revenue thus acquired, a portion, which might have been divided as profits, has been applied in paying the interest of capital, expended in the improvement of their supplies. I mention these things, not as claiming any high degree of merit for the Water

Companies,—they acted, if under no other restraint, at least under that of public opinion,—but because they are true, and because as much of a contrary tendency would appear to have gained belief with the public, in justice to them the truth should be known.

Assuming it then to be decided that the supply of water to London should be taken into the hands of some public authority, do the means exist of making the purchase on behalf of the public of the property of the Water Companies. I believe that such means do exist, and that it would be easy to complete an arrangement of the kind I have suggested, on terms which, while they should be fair to the Companies, would be ultimately very advantageous to the public. On the transfer of the water-works to the public, there would arise immediately a large increase of net income from three sources.

1st. From the consolidation of establishments, after allowing retiring pensions to such of the officers of the Companies as might not be retained by the new authorities.

2ndly. From the greater vigilance and strictness with which the rates would be collected by a public body, than they are now by the Companies, and the lower per centage on the collection, when forming part of a general rate collection for municipal purposes.

3dly. From the new rates to be received from

the householders (or owners of houses rather) who now refuse to take a water supply, but in the case supposed, would be compelled to take a supply and to pay for it.*

It would be easy to shew, if this were a fitting opportunity for entering into details, that from these sources—taking the Metropolis throughout—a large increase of net income might be obtained. A far larger, although prospective increase, would be derived from the growth of London, which would for many years add no inconsiderable increase year by year to the revenue derivable from a water supply. From the income thus at the disposal of the State, it would be easy to provide the means of purchase of the water works' property. This might be done either by raising the sum agreed on as the price of the works, on the security of the rates, as was proposed in the Health of Towns' Bill, as first brought in by Government in 1847, or by a rent charge. By either mode the means would exist of giving to the existing Companies the full value of their property, and yet of providing prospectively a surplus income, which at no very remote period would become considerable.

* The fresh income from this source would be very large, if the statement so widely circulated of there being 70,000 houses in London without a water supply were true. But there can be no doubt, I believe, that this is an exaggeration, still the number of unsupplied tenements is considerable, and the fresh income to be derived from serving them, would, in consequence, be of importance.

This surplus might either be employed as a sinking fund for the gradual extinction of the rates,—or it might be kept in hand as a means of general improvement of the Metropolis. In my own opinion, it would be better to devote it to the latter purpose. I do not believe that a water-rate would ever be felt as an onerous tax,—because it is light compared with the benefits of which it is the price. I doubt whether in the highest rated house in London, the rate paid is one half as much as the mere labour of pumping the water to the upper stories, if it were given gratis in the ground floor—would amount to. It is to be considered too, that if the supply were gratuitous, different classes and individuals would profit by the exemption in very unequal proportions. A rich man would use water for baths, and in every way which convenience or luxury could dictate,—a poor one would only have such use of it as the cheapest apparatus would permit. Whatever were the decision, however, on this head, there need, I am satisfied, be no doubt as to the main point, *viz.* that the means exist of concluding the purchase of the water works on terms alike just to the present proprietors and advantageous to the public.

If such an arrangement were carried into effect, all other alterations and improvements would follow as a matter of course,—they would be in the hands of an authority which could have no other conceivable object, than affording to the public the best possible supply on the lowest possible terms. Should

it, however, not be considered expedient to make this change, but better to leave the supply (conformably, no doubt, with our usual mode of dealing with such matters in this country), as heretofore, in the hands of individuals—

We have then to consider—

1st. What are the improvements required? and,
2ndly. Through what agency they may best be accomplished.

To deal first with the latter point. It seems to me impossible to doubt, that whatever may be the improvements required in the supply of water to the Metropolis, every consideration, whether of justice or policy, would demand that they should be effected through the instrumentality of the existing Companies. I will not here repeat, what I have said of the mode in which the Companies have discharged their parliamentary obligations—I know that it cannot be impugned,—but, waiving all claim for preference on such grounds, it is perfectly clear that the public is even more interested than the Companies themselves in deprecating the intervention of fresh adventurers. I assume, as a point beyond dispute, that Parliament will not again sanction the utter waste of capital which results from competition, or again subject the public to the insufferable annoyance of double or treble sets of mains laid down in the streets of the Metropolis; were that possible, the consequences would be such as I have pointed out, and I need not recur to them. But, supposing

new Companies to be established, with the sanction of the Legislature, to bring water from sources other than the present, but without the power of distributing it, what would be the result? Either they must receive from Parliament powers for the compulsory purchase of the property of the existing Companies, and become themselves the distributors of water, or they must have a like power of enforcing on the present Companies the use of the water they had procured. But, on the former alternative, as they must of necessity give the full value of the property of the existing Companies (for on no other terms would Parliament sanction its being taken), they would commence their career burthened with a larger capital than that on which the present Companies are now paying dividends, in addition to the sums which they would have to disburse on their own undertakings. The second supposition would involve equal or greater difficulties. By what authority, and on what conditions, should the price to be paid for water by the old Companies to the new, be determined? Would it be reasonable to call on them to pay an interest which might absorb their whole profits, on sums—over the outlay of which they would have had no control? Would it again be an expedient arrangement for the public, that one set of functionaries should have the responsibility of giving a daily supply of water, and another the duty of providing it? It seems to me, I confess, that

either of these suppositions involves difficulties of so grave a kind, as, apart from all considerations of justice to the old Companies, to place out of the question the sanction of the Legislature being given to any new Companies for the supply of water to London.

These difficulties, moreover, would be gratuitously incurred. As the inclination of the existing Companies to make whatever improvements may be required, cannot be doubted,—so it is clear that they have the means of effecting them on cheaper terms than any new associations. They possess all the necessary machinery for distribution, they could transfer to new sources, were it necessary, their mechanical power, they have in their service engineering talent of the highest order, as well as experienced servants in every other department of water-works' administration. From being already in possession of incomes, they have the power of raising money on advantageous terms, while in securing their present position, they have a motive for being contented with a less return on outlay than could fairly be imposed on any fresh adventurers. It is not necessary to enter upon the question of what may be the nature and extent of the improvements required. I have already expressed an opinion on that head, but I feel that the Companies have scarcely a right to any voice in the ultimate decision of this matter. Some impartial authority must decide between

them and the public. That they will bow to such a decision, and cheerfully undertake whatever improvements may be pronounced necessary for the public health or convenience, I am perfectly satisfied. It would be their duty so to do, but it would be also their interest,—as clearly as it would be the interest of the public, to oppose the intervention of fresh capital.

On the supposition I am now considering, viz.—that the supply of water should be left in the hands of the existing Companies,—it seems to me inevitable that the question of price should form part of an arrangement, which, as it would be permanent, should be in all respects well considered. I have hitherto, for obvious reasons, abstained from touching on this branch of the subject—and I will now only say with reference to it, that I have little doubt, an agreement may be come to, which would be alike fair to the Companies, and advantageous to the public. In return for that exclusive possession of given districts, which, if it be clearly the interest of the public to permit—it is yet, no less clearly their interest to preserve, it may be fairly required of them to submit to a limitation of profits. A provision of this kind, is now, I believe, invariably inserted in all bills establishing Companies for the supply of water, or the discharge of similar functions. Such provisions, are, for obvious reasons of justice, prospective—applying, that is, only to capital to be invested—but under the peculiar circumstances of the

case, I can see no unfairness in calling on the Metropolitan Water Companies, to acquiesce in a similar limitation. A certain rate of profit on their capitals should be agreed on — any increase of income beyond what would be necessary for securing that rate, to be applied not in augmentation of dividends, but in diminution of the charge for water.

In such an arrangement as we are considering, there would be many minor points of regulation to which it would be necessary to attend. I can now only advert to the more important of these regulations,—or rather to the principles on which they should be framed. On one hand they should be such as to guard against the possibility of abuse of their powers by the Companies,—on the other, to enable them efficiently to discharge the new duties which must be imposed on them. In conformity with one of the recommendations of the Committee of 1821, there should be a power given to one or more Justices, to adjudicate (with the right, however, of either party to appeal) in all cases of dispute between a Water Company and their tenants. There should be, agreeably to the provisions of the Health of Towns' Act, an obligation imposed on them to supply, on terms to be decided by some impartial referee, all water required for sanitary purposes, including in this term the supply of baths and wash houses, if established by any public authority. They should likewise be required, in conformity with the provisions of the same Act, to supply,

on terms to be settled in like manner, all houses below a certain scale in point of size or rent. To enable them the more efficiently to discharge this duty, they should be required to fit such houses with the necessary apparatus,—being empowered, of course, to add to the water rent, an agreed rate of interest on the outlay. It would be possible—as has been already explained—to give continuous supply to the humbler class of tenements without an entire change of the present system; but if it be thought advisable (as on general grounds it undoubtedly would be) to substitute throughout the metropolis the continuous for the intermittent system, then the Companies must be armed with an express enactment of the legislature for that purpose. All their Acts contain penalties against waste; but the amplest experience shows the utter inefficacy of these provisions. There is but one condition on which continuous supply in London is possible, *viz.*: that there should be a power on the part of those by whom water is distributed to cut off the supply from any house in which there is a cistern with a waste pipe. Any regulation short of this, I am satisfied, would be useless. I need scarcely say, that at present the Companies have no such power. There are many minor arrangements (some probably which would be suggested by the provisions of the “General Waterworks Act,” passed two years since) which it would be desirable to make, but none, I am satisfied,

which it would be difficult to adjust, if approached in a fair spirit. Such a spirit I am confident will exist on the part of those authorities who will have to act on behalf of the public in this matter,—such a spirit it will be as clearly the interest as it will be the duty of the Companies likewise to manifest.

These remarks on a subject which has for some years occupied much of my attention, have extended to a greater length than I had anticipated,—but my purpose in making them public will be fully answered if I should have succeeded in throwing any useful light on a question of no trifling importance. It would be a source of yet greater satisfaction to me, if I could suppose that I had imparted to my readers in any degree my own conviction, that the interests,—well understood,—of the Companies and the Public coincide, and that whatever improvements may be required in the supply of water to the Metropolis, are not only compatible with,—but may be best achieved by a policy which will at the same time be just to those by whom that supply has been hitherto administered.

APPENDIX.

I.

GRAND JUNCTION WATER WORKS COMPANY.

AN ABSTRACT of the number of houses in this Company's district that are not supplied with water from the Company's works ; — to which is added the number of houses that are not separately laid on, but which are supplied from a tank or cistern common to two or more houses :—

Number of houses without any known supply of water	95
Number of houses supplied from spring water wells	131
Number of houses not separately laid on but drawing their supply from tanks or cisterns supplied by the Company	142
	368

SOUTHWARK AND VAUXHALL WATER COMPANY.

AN ABSTRACT of the number of houses comprised within the district south of the Thames supplied by the Southwark and Vauxhall Company (and in part by the Lambeth Company, the mains of the two Companies being in several parishes intermixed), in which is set forth the number of houses separately laid on, those which take their supply from common cocks and stand pipes, the number supplied by spring and tide wells, and those without any known supply :—

Number of houses separately laid on*	52,686
Number of houses supplied from common cocks or stand pipes	4,383
Number of houses supplied by spring and tide wells	5,231
Number of houses without any known supply	1,312
	63,612

* Of the above number, about 17,000 are supplied by the Lambeth Company.

No. II.

Experiments made by the Secretary and Engineer of the Grand Junction Water Works Company, to ascertain the Current of the Flood and Ebb Tides of the River Thames at Spring and Neap Tides, with a view to decide in what degree the Thames at Chelsea is affected by the Drainage Water of London.

MONDAY, 4th Feb. 1828.—A float was used, so constructed as to afford the means of ascertaining the velocity of the upper and under current.

	Hours.	Min.
It was put into the River at the flood about 100 feet from the shore, opposite the King's Scholars' Pond Sewer, at sixteen minutes before 2 o'clock P.M., and arrived at the Grand Junction Company's Dolphin in	1	8
And from thence to the Farm House in Mr. Hoare's Park, about midway between Putney and Hammersmith Bridges, where the tide ceased to flow	2	48
	-----	-----
	3	56
	-----	-----

FRIDAY, 8th Feb. 1828.—To ascertain the current of the ebb tide by the same means, the float was put into the River opposite the Farm House, where the tide ceased to flow, on the 4th instant, at a quarter past 10 o'clock A.M. and arrived at the Grand Junction Company's Dolphin in 2 hours and 48 minutes.

18th July, 28.

LONDON BRIDGE.

			Spring Tide, 14th February, 1828.				Neap Tide 21st February, 1828.			
	Miles	Fur.	Hours	Min.	Hours	Min.	Hours	Min.	Hours	Min.
Departed from London Br. at .	0	0	9	40	0	0	2	30	0	0
Arrived at Southwark Br. at .	0	2	9	55	0	15	2	45	0	15
„ Blackfriars Bridge .	0	4	10	12	0	17	3	5	0	20
„ Waterloo Bridge .	0	5	10	35	0	23	3	28	0	23
„ Westminster Bridge	0	5	11	3	0	28	3	54	0	26
„ Vauxhall Bridge .	1	0	11	38	0	35	4	25	0	31
„ Dolphin of Grand Junction Water Works }	1	1	12	2	0	44	5	0	0	35
„ Battersea Bridge .	0	7	12	50	0	28	5	28	0	28
„ Point Pleasant, Wandsworth . }	1	4	1	45	0	55	6	33	1	5
Distance above London Br. reached by the flood, both spring and neap }	6	4	Time occu- pied in asc- ending with Spring Tide. }		4	5	Time occu- pied ascend- ing with Neap Tides. }		4	3

Average velocity at Spring Tide in one hour 1 Mile $4\frac{36}{81}$ Furlongs.

Ditto at Neap Tide ditto 1 „ $4\frac{68}{81}$ „

VAUXHALL BRIDGE.

			Spring Tide, 4th February, 1828.				Neap Tide, 22nd February, 1828.			
	Miles	Fur.	Hours	Min.	Hours	Min.	Hours	Min.	Hours	Min.
Departed from Vauxhall Bridge	0	0	1	40	0	0	3	45	0	0
Arrived at Dolphin of Grand Junction Water Works }	1	1	2	52	1	12	4	55	1	10
„ Battersea Bridge }	0	7	3	23	0	31	5	29	0	34
„ 2nd house beyond meadow, above Point Pleasant, Wandsworth, when the flood stopped at neap . }	2	6	0	0	0	0	7	45	2	16
	4	6								
„ Putney Bridge }	0	2	4	38	1	15	0	0	0	0
„ Craven house, about one mile beyond Putney Bridge }	1	0	5	40	1	2	6	0	0	0
Distance above Vauxhall Bridge reached by the flood at spring }	6	0	Time occu- pied ascend- ing with Spring Tide. }		4	0	Time occu- pied ascend- ing with Neap Tide. }		4	0

Average velocity at Spring Tide, 1 Mile 4 Furlongs in one hour.

Ditto at Neap Tide, 1 „ 1½ „ in one hour.

	Miles	Fur.	Hours	Min.	Hours	Min.
Departed from Distillery at Wandsworth, about $1\frac{1}{2}$ mile above Battersea Bridge	0	0	1	45	0	0
Arrived at Battersea Bridge	1	4	3	3	1	18
„ Dolphin of Grand Junction Water Works' Company	0	7	3	33	0	30
	2	3			1	48

Average velocity, 1 Mile $2\frac{2}{3}$ Furlongs in one hour.

	Miles	Fur.	Hours	Min.	Hours	Min.
Departed from Craven House, about one mile above Putney Bridge	0	8	9	45	0	0
Arrived at Putney Bridge	1	0	10	45	1	0
„ Battersea Bridge	3	0	12	34	1	49
„ Grand Junction Water Works Company's Dolphin	0	7	1	3	0	29
	4	7			3	18

Average velocity, 1 Mile $3\frac{2}{3}$ Furlongs in one hour.

From the foregoing tables it would appear, that, whilst in starting from Vauxhall Bridge, there is a considerable difference between the mean velocity of Spring and Neap Tides, and consequently a considerable difference in the distance which the flood at those periods respectively ascends; from London Bridge, the flood tide at Spring and Neap is precisely similar in both those particulars.

It is evident that this cannot be the usual course of the tides; indeed, as the tides in the Thames are affected by many extraneous and incidental causes, such as particular winds, either resisting or retarding the influx of tides from the sea on the one hand, and a greater or less quantity of land-water on the other,

there must be perpetual variations of greater or less amount in the strength both of Spring and Neap Tides.

The following important results, however, seem sufficiently ascertained :—

FIRST.—That the flood-tide at Spring does not ascend more than about six miles and a-half from London Bridge, and six miles from Vauxhall Bridge ; it consequently flows beyond the Company's Dolphin at Chelsea only two miles three furlongs in the former, and four miles seven furlongs in the latter case.

SECONDLY.—That after *one hour and forty-eight minutes* of ebb, the whole of the Water that had been as low as the upper side of London Bridge, had returned past the Company's Dolphin ; and after *three hours and eighteen minutes*, the whole of the Water that had been as low as the upper side of Vauxhall Bridge, (that is, above the highest sewer of London) had also returned.

THIRDLY.—That as the length of the ebb at the Company's Works at Chelsea is seven hours and forty-two minutes, there must be six hours of every ebb, during which the Water can by no possibility have been affected by any drainage below London Bridge ; and four hours and a-half, during which it could not have been affected by any London drainage whatever.

FOURTHLY.—It also seems clear, that the drainage of London does not affect the middle of the stream during the ebb ; the sample of water taken at London Bridge being as bright as it could have been if taken at Richmond ; and it is therefore probable, that for a long period of the flood, the centre of the river remains unaffected by drainage water.

It is at all events clear, that the time necessary for the flood, from London and Vauxhall Bridges respectively, to arrive at Chelsea, must be added to the above stated portions of the ebb ; the time, therefore, in every twelve hours during which the Water at Chelsea is unaffected by London Drainage, would stand thus :—

If reckoned from London Bridge,

	Hours.	Min.
The flood reached the Company's Works in	. 2	42
Returned in	. 1	48
Deducted from length of Ebb at Chelsea	. 7	42
	—	5 54
	<hr/>	
	Hours .	8 36

If reckoned from Vauxhall Bridge,

	Hours.	Min.
The flood reached the Company's Works in	. 1	12
Returned in	. 3	18
Deducted from length of Ebb at Chelsea	. 7	42
	—	4 24
	<hr/>	
	Hours .	5 36

MEMORANDUM.—In starting from Vauxhall Bridge, the highest point to which the Spring Tide ascended was opposite Craven House, about three-quarters of a mile beyond Putney Bridge, which is two miles and a-half below the point at which it is proposed to take in the water, upon the plan of the West Middlesex and Grand Junction Water Companies.

18th July, 1828.

Wednesday, 12th December, 1849.

Flood at Vauxhall Bridge at a quarter past eight A.M. The float was a sphere of Alder, nine inches in diameter, attached by a cord two feet long to a ball of the same size, properly weighted. The Tide rose two feet before there was any current.

	Hours.	Min.
Started from Vauxhall Bridge at	. 8	30
Arrived at Southwark Waterworks Suction	. 9	15
„ Chelsea Waterworks	. 9	21
„ Red House, Battersea Fields	. 9	27
„ old site of Grand Junction Waterworks	. 9	35
„ Battersea Bridge	. 10	5
„ Two-mile post	. 11	19
„ Putney Bridge	. 11	33

	Hours	Min.
Arrived at Three-mile post	11	56
„ Suspension Bridge, Hammersmith	12	40
„ West Middlesex Waterworks	12	58
„ Five Mile Post	1	14
„ Chiswick Old Church	1	24
„ High water $5\frac{1}{4}$ miles from Battersea Bridge, and 6 furlongs above Hammersmith Bridge	1	35

Here the tide was stationary 20 minutes.

Tide commenced to ebb, and we started from the $5\frac{1}{4}$ miles

post above Battersea Bridge at	1	55
Arrived at Chiswick Old Church	2	0
„ Five Mile Post	2	8
„ West Middlesex Waterworks	2	20
„ Suspension Bridge, Hammersmith	2	35
„ Three Mile Post	3	11
„ Putney Bridge	3	29
„ Two Mile Post	3	40
„ Battersea Bridge	4	35
„ Old Site of Grand Junction Waterworks	4	57
„ Red House, Battersea Fields	5	4
„ Southwark Waterworks	5	11

No. III.

Copy of Analysis of Thames Water, made by DR. PEARSON and MR. GARDNER, and given in Evidence before the Commissioners, appointed in 1828 to inquire into the supply of Water in the Metropolis.

All the waters, when taken from the river, were slightly turbid, but by repose had become quite clear and rather bright, but not so bright as distilled water; the sediment which rendered the water rather turbid, it is presumed, having subsided, they were quite colourless, inodorous, tasteless, and did not feel rough on rubbing between the hands, more slightly decomposing soap than almost any spring water. No particles of air were seen suspended.

	Specific Gravity.	Muriate of Magnesia.	Muriate of Soda.	Sulphate of Lime.	Carbonate of Lime.	Silica and Vegetable or Carbonaceous Matter.	Amount of all the Ingredients in each Water.
		Grains	Grains	Grains	Grains	Grains	Grains
Distilled water being assumed as ..	1000.						
Teddington water from 1 Gallon	1000.18	.. 0.14	.. 1.0	.. 1.31	.. 8.55	.. 0.10	.. 11.10
Dolphin water at high water	1000.40	.. 0.28	.. 1.40	.. 1.44	.. 11.80	.. 0.30	.. 15.22
From the Surrey side,* opposite the Dolphin at high water	1000.40	.. 0.28	.. 1.30	.. 1.44	.. 10.60	.. 0.20	.. 13.72
Water from the second starling of the centre arch Battersea bridge .	1000.40	.. 0.20	.. 1.24	.. 1.30	.. 10.70	.. 0.20	.. 13.64
From 2nd starling of the centre arch of Battersea bridge at low water .	1000.40	.. 0.14	.. 1.09	.. 1.30	.. 9.10	.. 0.15	.. 11.78
From Surrey side opposite the Dolphin, 150 feet from the bank† .	1000.18	.. 0.14	.. 1.09	.. 1.22	.. 9.60	.. 0.15	.. 12.20
From the Dolphin, 5 minutes before 1 o'clock, half an hour after flood	1000.40	.. 0.28	.. 1.20	.. 1.30	.. 9.90	.. 0.20	.. 12.88
From the Dolphin, 20 minutes after 3 o'clock, p.m. tide half up	1000.30	.. 0.28	.. 1.26	.. 1.44	.. 10.20	.. 0.20	.. 13.38
From 2nd starling of Battersea bridge centre arch, at $\frac{1}{4}$ before 4, p. m.	1000.30	.. 0.28	.. 1.20	.. 1.44	.. 10.30	.. 0.20	.. 13.42
From Surrey Side opposite Dolphin, about 120 feet from the bank, 25 minutes after 3 o'clock	1000.40	.. 0.20	.. 1.18	.. 1.30	.. 10.0	.. 0.30	.. 13.98

It appears, then, according to the preceding analysis now submitted to consideration, that the Thames water, between Teddington Lock and the Dolphin at Chelsea, on examination from ten different places, contains, on the average, about thirteen grains of impregnating matter in each wine gallon, or three grains and a quarter in each quart; *i.e.* one grain and three-quarters in each pint, —the largest quantity being fifteen and a half grains, and the smallest being nearly eleven grains in each wine gallon; the largest quantity of carbonate of lime, (chalk or limestone) being eleven grains and nearly a half, and the smallest quantity being eight grains and a half, or nearly so in each wine gallon; *i.e.*

* About seventy yards from the point at which the Southwark and Vauxhall Water Company take their supply.

† The superior purity of this specimen shows the advantage of taking the Thames during the latter portion of the ebb. It will be observed, that the water at Battersea bridge, taken under these circumstances, is almost identical in character with the water at Teddington.

on the average about one grain and a quarter in each pint. The largest quantity of muriate of soda (common salt) being less than one grain and a half in a gallon, and the smallest being one grain in a gallon, *i. e.* one-eighth of a grain in each pint; the largest quantity of muriate of magnesia being one grain and 28-1000 of a grain in a gallon of water of sulphate of lime, being less than one grain and a half in a gallon. Siliceous earth and vegetable carbonaceous matter being 38-100 of a grain in the largest quantity. It will be easily imaginable from these results, that the impregnating ingredients of the Thames water are as perfectly harmless as any spring water of the purest kind used in common life; indeed, there is probably not a spring, with the exception of Malvern and one or two more, which are so pure as the Thames water. The well known fact that the Thames water becomes frequently offensive after being confined in casks, is owing to the dissolution of the wood of the vessel, or at least, it is chiefly, if not entirely owing to this circumstance, and perhaps occasionally from adventitious suspended matters. The same offensive smell is liable to occur from any other water under similar circumstances.

No. IV.

Copy of a Letter from DR. BOSTOCK to the SECRETARY of the West Middlesex Company, dated 18th June, 1834.

Upper Bedford Place, June 18, 1834.

SIR,

At your request I have placed some of the most important of the results which I obtained from the analysis of the fourteen specimens of water sent me by Mr. Mills, in a tabular form. I also send you a few remarks connected with the subject, which perhaps may appear to you of some importance.

“ In the first place it is obvious, that before we can decide upon the quality of any particular water, it is essential to know under what circumstances it was procured, as the same waters will be found to differ very much at different times. Among the

most influential of the causes which produce those differences would appear to be the extremes of wet or drought, the first heavy rain after dry weather, and the melting of snow.

Secondly—"Water that has been long exposed to the sun and air in open reservoirs, especially in hot weather, appears to contract a certain degree of impurity; perhaps from the ova and the exuvia of insects, and perhaps also from the germination of minute vegetables; this seems to be the case even with water that has been filtered. In the reservoirs that are contiguous to London, it also acquires a tinge and a flavour, which may be attributed to particles of smoke deposited and suspended in it.

Thirdly—"From the experience I have had on the subject, I am disposed to think, that the water of the Thames in the neighbourhood of the metropolis is less impure than it was six years ago. This circumstance has, I understand, been noticed by others, and has been supposed to depend upon the removal of the Old London Bridge, by which the water has a more free outlet, and therefore carries down a part of the impurities which it formerly retained.

Fourthly—"The condition of the water, in different states of the tide, was formerly found to be considerably different, and my late experiments confirm this fact. But on this point, and on that referred to in the last head, a greater number of experiments would be necessary, and those made under various circumstances, before we could be warranted in coming to a decisive conclusion.

Fifthly—"The above remarks would lead us to the inference, that, so far as the quality of the water is concerned, the Thames when purified, either by subsidence or filtration, as may be found necessary or expedient, has this advantage over any smaller stream that, in consequence of its bulk, and of its waters being collected from a greater range of country, it is less liable to be affected by various incidental circumstances, and will therefore be more uniform, not only in its quantity but likewise in its quality, than any river of less magnitude."

I am, Sir,

Your most obedient,

(Signed)

J. BOSTOCK.

Abstract of the Analysis of the Fourteen Specimens of Water sent by MR. MILLS to DR. BOSTOCK, referred to in the preceding Letter.

Class.	No.	Source.	Specific Gravity.	Contents in 10,000 Grains.	Remarks.
1	1	Colney Bridge	100,019	1 2 grains	{ Composed of 8 Carbonate of Lime 2 Sulphate of do. 2 Muriate of Soda & Magnesia <hr/> 1 2 <hr/>
2	{ 21 32	{ Thames at Ham- mersmith Lee at the Engine . . }	100,022	{ Nearly the same as No. 1.	
3	{ 4 13 22 33	{ Colne at Thorney Mill Wandle at Wands- worth Chelsea filtered . . New River at Is- lington }	100,025	{ About 2 grains	{ The proportion nearly as above, but a little more in quantity.
4	{ 2 11 12 31	{ Verulam at St. Al- bans Wandle at Croydon Do. at Mitcham . New River at Chad- well }	100,050	{ About 2 5 grs	{ These waters contain rather a larger portion of Carbonate of Lime than class 3.
5	3	Colne at Rickmans- worth }	..	2 8 grains	{ Composed of 1 9 Carbonate of Lime 4 Sulphate of do. 5 Muriate of Soda & Magnesia <hr/> 2 8 <hr/>
6	34	East London Reservoir	100,070	..	{ This water contained a little more Sulphuric Acid.
7	41	Treasury Pump	100,130	9 0 grains	{ Composed of 4 9 Carbonate of Lime 2 3 Sulphate of do. 1 8 Muriate of Soda & Magnesia <hr/> 9 0 <hr/>

“ As the waters were examined in November, after the autumnal rains, it is probable they contained less saline matter than their average quantity.* It is also to be observed, that they were all of them nearly free from mechanical impurity, probably depending, in some measure, upon the mode in which they were procured.”

* This observation would be especially applicable to the Colne at Colney Bridge, and the Wandle at Wandsworth.

No. V.

(COPY.)

Royal Mint, 9th March, 1849.

SIR,

According to your instructions, I have examined 21 samples of water sent to me by the several water companies, and distinguished by the marks annexed to them in the inclosed list. I am ignorant of the sources whence these waters may have been respectively derived, and have therefore enumerated them nearly in the order in which the several samples were received.

The leading ingredient in all these waters is carbonate of lime, of which, with the exception of Nos. 60X and 61X, they contain from 13 to 18 grains in the gallon (about the average quantity contained in the Thames and New River water.) They also contain small quantities of chlorides, and still smaller of sulphates, with the exception of sample 14, marked XXAΘ, in which the sulphates and chlorides appear nearly equal in quantity. They

all afford traces of organic matter, and contain free carbonic acid. Nos. 60X and 61X are probably from some distinct source, they are turbid and discoloured by ochraceous or clayey matters, and require filtering; but when filtered in a proper way are purer and softer than any of the other samples.

I must observe with regard to the test called Clark's test, that although it generally gives a tolerably good indication of the relative softness and hardness of water (pure or distilled water being represented by unity), it is perfectly useless as a guide to the absolute quantity of saline or foreign matter contained in the water, it being almost exclusively affected by the presence of the salts of lime. But as all the present waters are characterized by those salts, and especially by carbonate of lime, Clark's numbers run tolerably parallel with the actual per centage of saline matter in the water. As far as I have been able to ascertain, none of these waters possess any remarkable peculiarities such as would induce me to recommend that they should be submitted to a more elaborate method of analysis.

I remain, Sir,

Your faithful Servant,

(Signed)

WM. THOS. BRANDE.

To Joseph Blunt, Esq.

3, Winchester Buildings.

ANALYSIS OF SAMPLES OF WATER.

No.	Marks.	Clark's Test.	Solid Contents in one gallon.	
			Grs.	
1	A 1	15½	20	New River
2	B 2	16	21	do.
3	C 3	16 ¹ / ₁₀	21	do.
4	No. 45	16	21·5	Southwark and Vauxhall
5	No. 46	15½	20·1	Southwark and Vauxhall
6	No. 33	17	22·5	Thames at Medenham
7	do.	..	..	do.
8	do.	..	..	do.
9	No. 51 X	16½	22	Chelsea
10	52 X	16	21·2	do.
11	53 X	15¼	23	do.
12	54 X	15¾	21	do.
13	55 X	15¾	21·1	do.
14	XX A	17	22·3	East London
15	XX B *	17¼	23	do.
16	I	15¼	20·5	Grand Junction
17	O	15¼	20·1	do.
18	U	15¼	21	do.
19	R B	14 ¹ / ₁₀	19·5	West Middlesex
20	60 X	8¾	11·5	Grand Junction Canal, Kensal Green
21	61 X	8¾	11·8	
22	62 X	17	23	do. at West Drayton.
23	63 X	16¾	22	

Numbers 20 and 21, marked 60X and 61X, were turbid and required filtration, and 22 and 23 not quite clear.

(Signed) WILLIAM THOS. BRANDE.

8th March, 1849.

The specimens, when sent to Mr. Brande, had only the marks and numbers,—I have added the names. The explanation of the peculiar character of X60 and X61, is to be found in the fact that they were taken from the Grand Junction Canal after it has received the water from the Ruislip reservoir, which collects drainage (rain water). The specimens X62 and X63 are from the Canal, above the junction of the Ruislip Feeder, and where it is filled with Colne water. W. C.

No. VI.

Analysis of Specimens of Water produced by MR. BRANDE, in a Lecture at the Royal Institution, in 1846.

One Gallon.	THAMES.				LEA.	NEW RIVER.	DEEP WELLS.		
	Chelsea.	London Bridge.	Teddington.	Colne.			Brewery of Messrs.—	Charing Cross.	Mint.
Carbonate of Lime.	16 5	16 4	14 8	18 1	10 2	14 7	6 2	3 1	1 5
Sulphate of Lime	1 5	6	1 2	1 2	6 2	1 6	..	..	..
Salt	1 7	2	1 4	2	6 6	1 7	12 7	25 7	8 3
Sulphate of Soda . . . . .	..	..	..	..	..	..	24 2	19 6	18 1
Carbonate of Magnesia	t	t	t	..	..	..	1 1	2 4	..
Phosphates . . . . .	..	..	..	..	..	..	0 4	t	t
Silicia	t	t	t	t	2 4	1 2	0 4	0 7	t
Carbonate of Soda . . . . .	..	..	.	..	..	..	11 7	14 6	12
	19 7	24 4	17 4	21 3	25 4	19 2	56 7	66 1	39 9

No. VII.

GRAND JUNCTION WATER WORKS.

A detailed abstract from the "Labourers' Day Book," shewing the number and nature of the different works performed in this Company's District during the 12 months ending September 30th, 1840, which would have occasioned interruptions in the supply of water to the Tenants, supposing such supply had been constant instead of intermittent with the time during which it was necessary to shut off the water.

Date.	Packing or Fitting new Spindles to Side Service.				Mains & Iron Services Repaired.			Laying on, cutting off, relaying on, repairing Lead Service Pipes.			Setting up Leaky Joints on Mains and Service Pipes.			Alterations and Extensions.		Defective Cocks taken out and replaced with perfect ones.		Faults not found at the end of the day's work.
	Side Service Cocks.	Branch Main Cocks.	District Main Cocks.	Feed Main Cocks.	Side Service Pipes.	Branch Main Pipes.	District Main Pipes.	Lead Service Pipes.	Feed Main.	Branch Main.	Services.	Hours.	Hours.	Hours.	Main Cocks.	Service Cocks.		
1848 & 1849.																		
October	No. of Cocks packed.	No. of New Spindles fitted.	No. of Cocks packed.	To do this nearly the whole district is without a supply of water.	3	2	..	112	..	2	10	8	..	..	..	7
November	12	3	..		18	..	..	112	..	..	16	15	..	..	..	12
December	17	5	4		9	5	..	125	..	..	8	7	..	..	..	5
January	15	4	1		7	..	..	101	..	..	13	3	..	..	..	8
February	60	3	1		3	..	..	116	1	..	17	..	..	..	..	1
March	29	2	1		5	..	..	190	..	..	25	2	..	..	..	3
April	34	2	3		1	..	..	99	1	..	5	4	..	..	..	1
May	39	1	..		1	..	..	108	..	..	4	4	..	..	..	2
June	34	2	1		..	..	..	92	..	..	5	4	..	..	..	7
July	21	..	15		..	..	..	120	..	..	7	1	..	..	..	1
August	35	3	..		1	1	..	115	..	..	5	8	..	..	..	3
September	26	2	6		4	..	..	145	..	..	4	2	..	..	..	2
Totals	342	25	14		51	7	2	1435	2	51	130	72	2	2	13	51		
Average time during which the water must be shut off.	Hours 1/2	Hours 1 1/2 to 2	Hours 1/2	Hours 1/2	Hours 1 1/2 to 3	Hours 1 1/2 to 3	Hours 2 to 3 1/2	Hours 1/2 to 1 1/2	Hours 2 to 3 1/2	Hours 3 to 6	Hours 2 1/2 to 3 1/2	Hours 1 1/2 to 2 1/2	Hours 3 to 6	Hours 2 1/2 to 3 1/2	Hours 1 1/2 to 2 1/2	Hours 2 1/2 to 3 1/2	Hours 3 to 6	

Note :—The total number of interruptions from the above causes during the year was 2316, being an average of 6.34 per day, Sundays' included.

J. W. HUGHES.

No. VIII.

Extract from the City of Coventry Water Works' Regulations.

Mr. THOMAS HAWKESLEY, Engineer.

1. The Corporation will, at their own cost, lay down and maintain all the lead or other branches, extending from their main to the side of the public highway in which such main is situate; and will, at their own cost, carry the pipe through the frontage wall (if there be one), and six inches beyond; or otherwise equivalently allow fifteen inches in length for the owner's or occupier's plumber to connect his work to.

2. The owner or occupier must, at his own expense, lay down and maintain all the pipes and apparatus upon his premises, or for his use, and of the strengths and descriptions, and subject to the rules following, viz. :—

A. The pipes must be of not less than the following weights*—

$\frac{1}{2}$ inch	. . . . .	7 lbs. per yard
$\frac{3}{4}$ „	. . . . .	11 „
1 „	. . . . .	16 „
$1\frac{1}{4}$ „	. . . . .	22 „

B. The drawing cocks must be of brass, and of the kind called “screw down,”† of Lambert's or Carter's Patents; and in courts of houses must be protected by a casing, and either made self-acting, or to open with keys.

C. Every cistern must be provided with a ball-cock, and proper means of access and inspection, but must not have an overflow or waste-pipe, and if any should exist, the same must be stopped before the water is turned on.

D. Every water-closet must be of one of the kinds known as the “pan closet,” or the “self-acting closet,” and must be provided with a full and complete apparatus, comprising *service cistern*,‡ basin, pan, trap, &c. excepting that the self-acting

* Sufficient for 200 feet pressure.

† The screw works of Guest and Grimes are the best.

‡ To prevent the necessity of the disgusting practice of inserting the water pipe into the basin.

closet may have substituted for the pan, a service box and double valve, to let down a regulated quantity of water. The pan closet is, however, recommended to be used.

3. The water supplied must not be allowed to run to waste, either wilfully or by neglect, nor must it be used for any other purpose, or to any greater extent, than shall have been agreed for.

4. No pipes must be attached to the works of the Corporation or to any pipes or apparatus connected therewith, nor must any alterations be made in any existing pipes or apparatus without due notice being given to and the consent of the proper officer of the Corporation being first obtained.

5. The supply and use of water for the purposes of trade and manufacture must be open to inspection and admeasurement whenever required, and such information must be from time to time afforded as will be sufficient to enable the Corporation to obtain a satisfactory account of the quantity of water actually consumed.

6. The Corporation are desirous that the private business shall be open to all the plumbers of the city; but inasmuch as it is essential to the protection of the interests of the consumers, that the work shall be well executed, and that the Waterworks Committee shall possess full knowledge of the state of the undertaking, it is announced that no plumber or other workman, will be allowed to do or perform, any work connected with the supply of water till he shall have been admitted and enrolled by the Corporation as "an authorized Water Works plumber," and shall have entered into a written engagement to conform to and comply with the rules and regulations of the Corporation in relation to the management of the Water Works. If at any time afterwards any such plumber shall be found guilty of breaking or evading the said rules or regulations, either by himself or his workmen, or shall refuse to communicate any information required of him in regard to any work done by him or under his superintendence, his name will be struck out from the list of "authorized plumbers," and will forthwith be advertised as so struck off.

7. No consumer of water shall employ in or about the Water Works, or any pipes or apparatus connected therewith, any person who has not been admitted "an authorized plumber," or any plumber whose name shall have been struck off the list as aforesaid.

No. IX.

Summer Street, Southwark,
15th December, 1849.

SIR,

In reply to your inquiry I beg to submit the following plans shewing by what means a partial system of constant supply could be engrafted on the present service of the Companies. The plans are intended—in addition to dispensing with cisterns in small houses—to afford protection in low and poor districts to the house service pipes, many of which are of the slightest material, and would not bear the pressure of the great head of water which is acting over the whole district. One plan has in view the supply of houses or establishments where it may be considered desirable to have but one cistern to receive the water from the Company's mains, in place of many, and yet at the same time it may be necessary to have the means of drawing the water on every floor at the same time.

By plan No. 1, a number of houses can be supplied from one small cistern marked A, placed on the top of the house nearest the Water Company's leading main, the cistern acting as a sort of stand pipe or safety valve to the whole of the house pipeage under its influence,—and by placing a stop cock S.C. on the Water Company's main M, and conveying a supply pipe B to the cistern A, and a service pipe C from thence to the same

main at the back of the stop-cock, it will keep the house pipes always charged, and enable persons to draw the water at all times from every floor of the houses.

Plan No. 2, shews a large establishment with one cistern A, at the highest elevation to be fed constantly from the Water Company's main F through the lead service pipes DDD, leading to every situation where cisterns EEE have been in use.—This arrangement is made to obviate the necessity of taking a service pipe from the Water Company's main to every cistern, which would be necessary if all the cisterns were supplied from one rising service (unless of very large dimensions) and the water required at the same time at different levels.

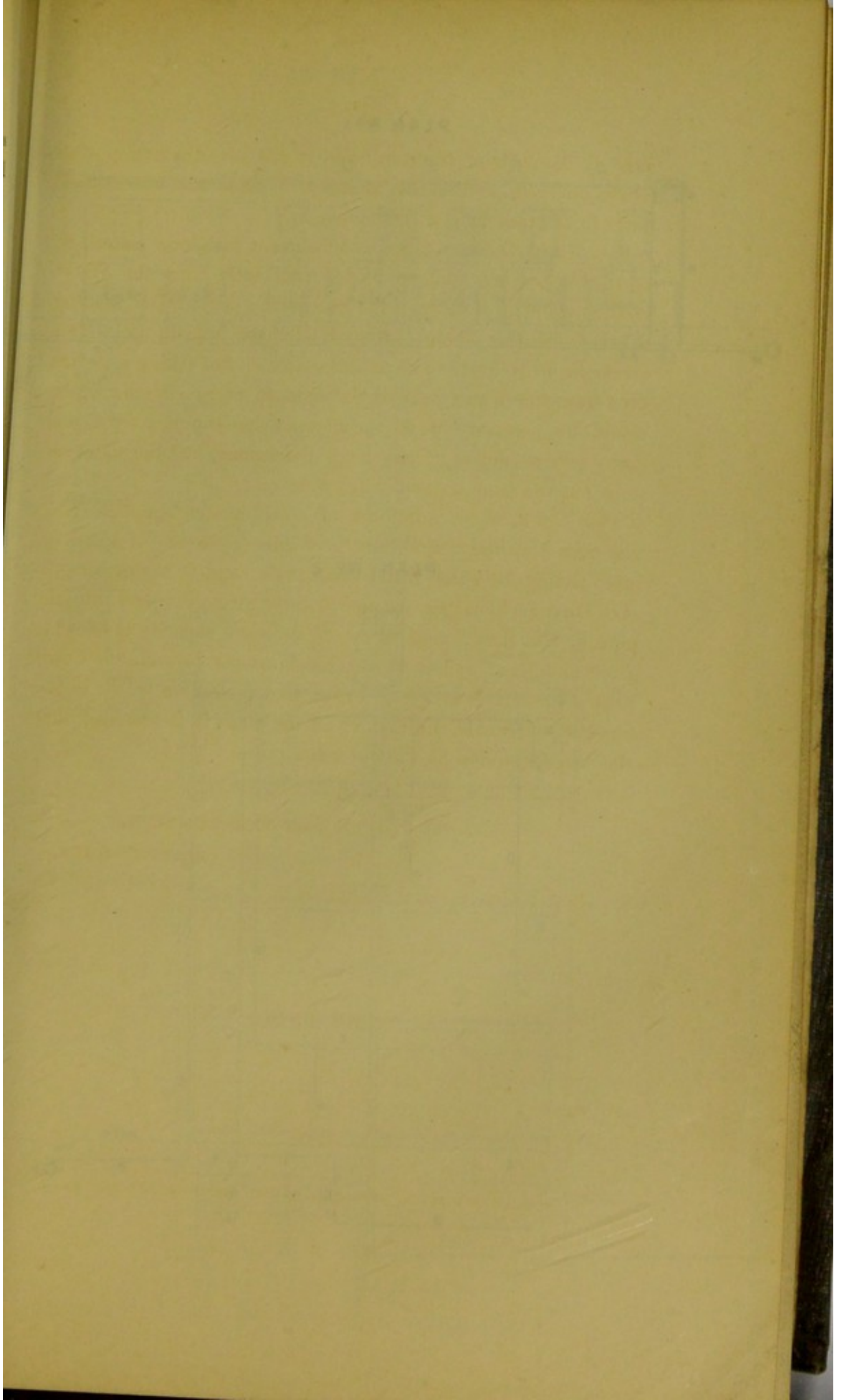
Plan No. 3, shews a number of small houses supplied from one tank A on the intermittent principle—by means of a supply pipe leading from the Water Company's main F, having a stop-cock D, and a house service pipe C leading from the tank into the pipe F, the tank being made of sufficient capacity to afford a given number of gallons to each tenement per day, and the Company's present iron pipes being used as feeders to the house services.—I should add that in all the plans it is assumed that the cisterns should be without waste pipes.

I am, Sir,

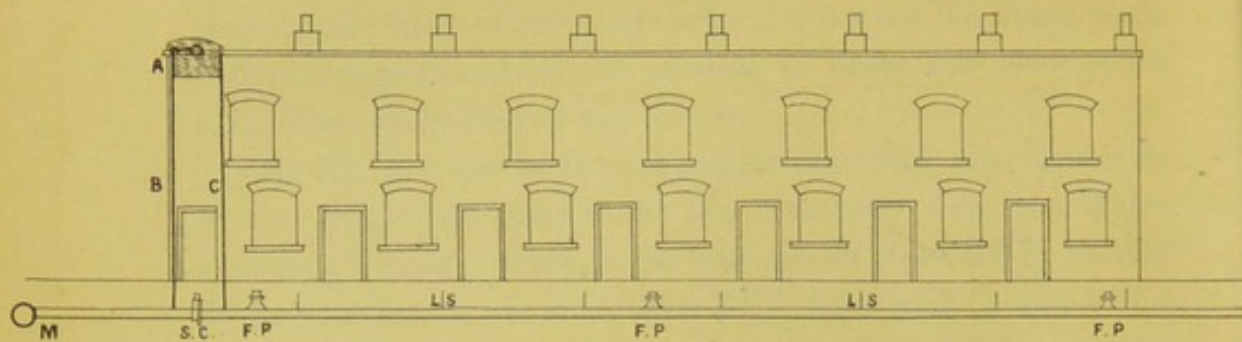
Your obedient servant,

JOSEPH QUICK,
Engineer.

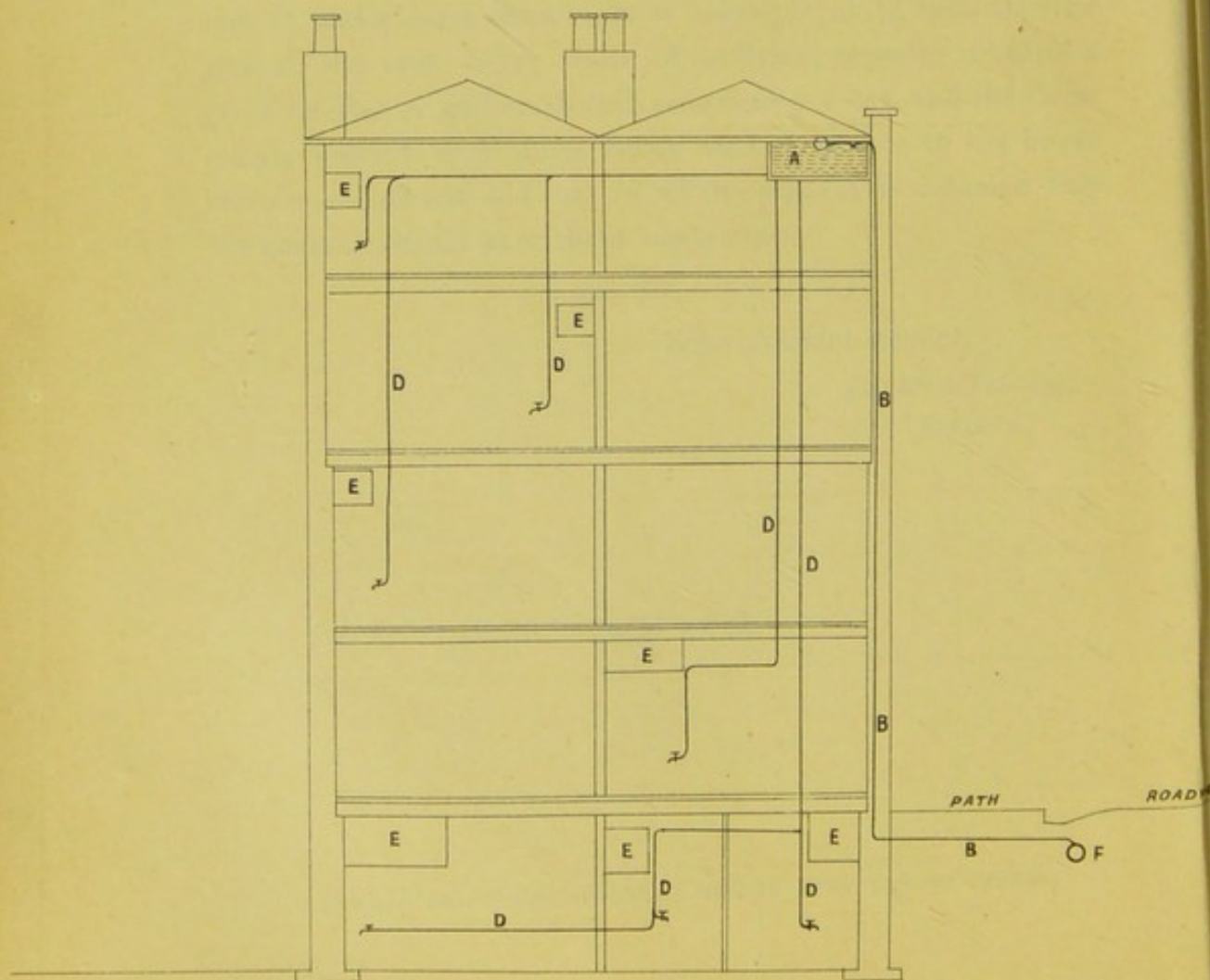
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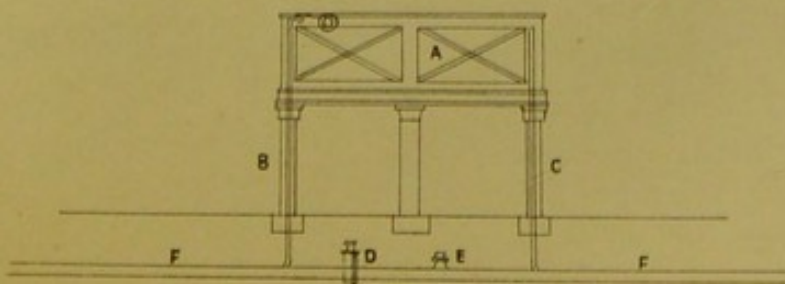
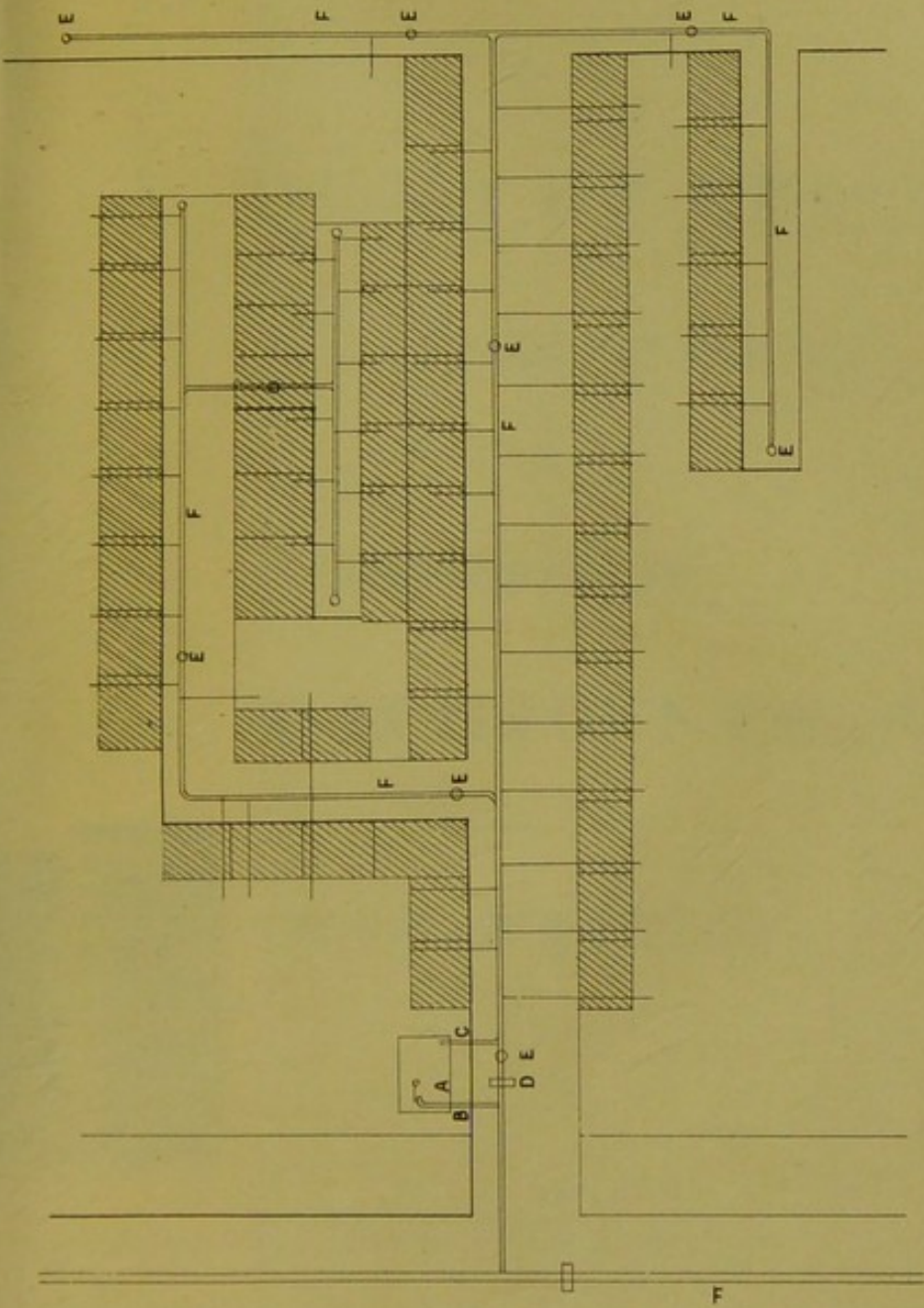
PLAN N° 1.



PLAN N° 2.



PLAN N° 3.



and they, and the use of gross and unprofessional language (which latter
never strengthens an argument) without, in the slightest degree, contri-
buting to the value of the Inspector's report; or that the con-
clusions are drawn at the end of his report, are supported by either facts or

As regards the general question of estimate and expense, I may per-
haps be allowed to say, that in preparing my preliminary estimate, it was con-
sidered that all other preliminary estimates before the expense of making
detailed drawings had been worked out, as one representing the estimate
of the cost of the works contemplated by the Local Board; and as it
had not been considered wise to incur the expense of making detailed
drawings before going to the Board, it was thought that the amount
of estimate should not be reduced, although it was well known to you, that
a great deal of work was done, as has been anticipated by some parties, it
would most probably be considered reduced. However, the General
Board had made the estimate and estimate estimate, founded upon the
detailed and accurate drawings to be submitted to the Inspector and Judge,
and of course with preliminary estimates referred to the Local Board were
submitted. It is to be regretted that the Local Board had to have
taken this estimate, the responsibility of estimate, as their pro-
prietors, and of the Inspector's report, who are disputed by
the General Board to report on the estimate of civil engineers; and who
might be expected to make them to a great extent, however objec-
tionable it may be, and to view all the works in accordance with
the views of the General Board of Health and Civil Engineers.

I believe that I have now given an answer to most of the Inspector's
objections upon my estimate. If I have omitted any points which you
and the Committee think important to be answered, I shall be very happy
to give them my attention: the Inspector's report is very voluminous, and
it contains a stronger desire to understand without restriction, than to treat
the subject with candour and fairness.

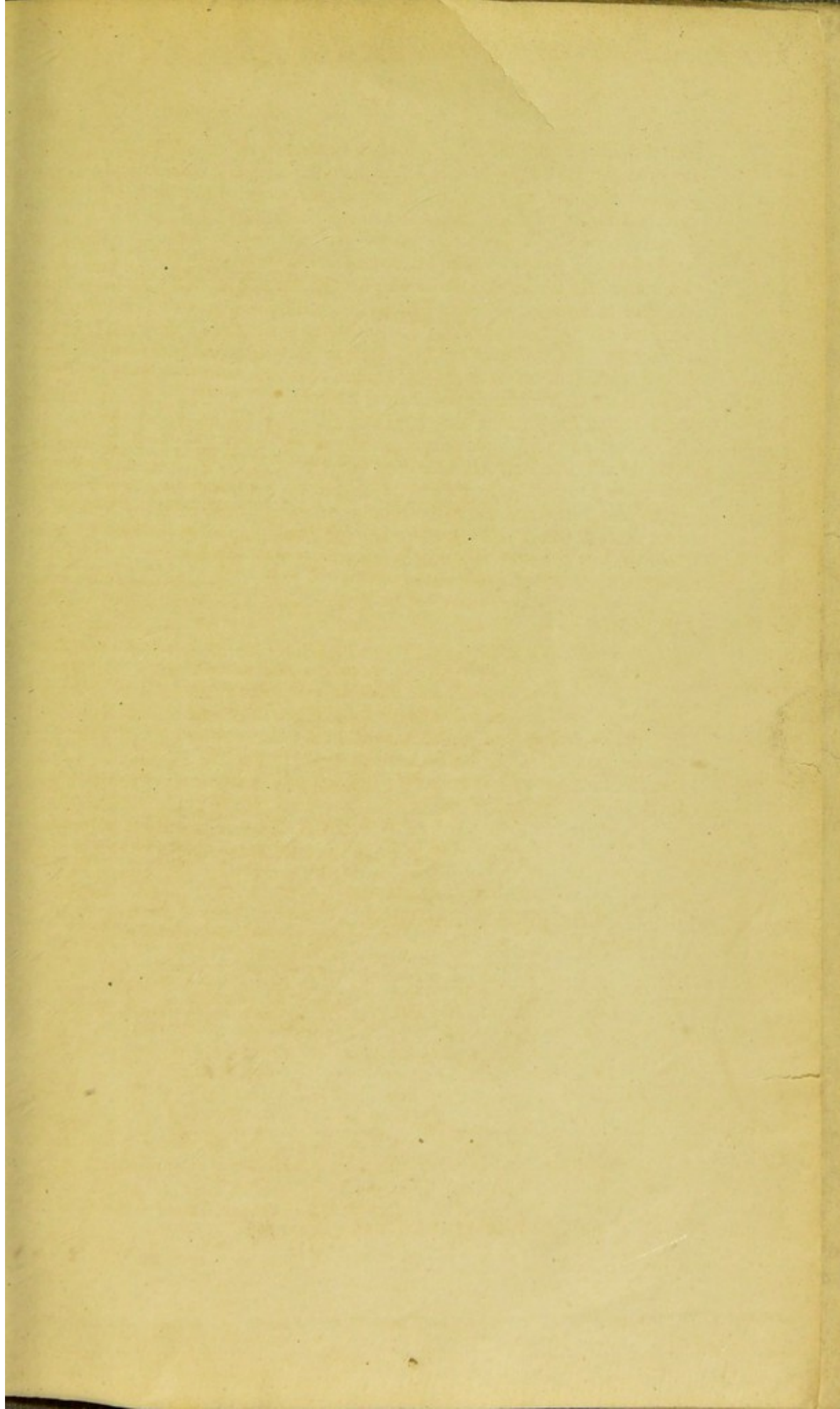
Apologies for the length of this reply.

I am, Sir,

Your most obedient Servant,

THOMAS WIGSTED.

Inspector.



11

11

TIGHT GUTTER

